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**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
**REGION 5**

**DATE:** Friday, July 16, 1999

**SUBJECT:** TRANSMITTAL OF THE BOFORS NOBEL SUPERFUND SITE SECOND AMENDMENT TO THE RECORD OF DECISION FOR THE FIRST OPERABLE UNIT

**FROM:** Bill Bolen, Acting Chief
Remedial Response Branch #1

Gail Ginsberg
Regional Counsel

**TO:** William E. Muno, Director
Superfund Division

Enclosed for your review and signature is the Bofors-Nobel Site Second Amendment to the Record of Decision for Operable Unit (O.U.) #1. The Amendment includes the Declaration, Decision Summary, and Responsiveness Summary. The latest update to the Administrative Record is also included and additional documents will be added shortly.

We concur with the amended Remedial Action for the second phase of the first operable unit for the Bofors-Nobel site which replaces the construction of two on-site RCRA type landfill cells with a below grade barrier wall, protective cap, and phytoremediation. This amended O.U. #1 remedy requires restoration of groundwater as the first phase through containment, extraction, and treatment. Protection of human health and the environment is provided through treatment of contamination by phytoremediation and concurrent maintenance of containment until treatment effectiveness is determined or remediation standards are met.

Please feel free to contact us if you have any questions.

**DECLARATION FOR THE SECOND AMENDMENT TO THE RECORD OF DECISION**

SITE NAME AND LOCATION

Bofors-Nobel Site
Muskegon, Michigan

PURPOSE

This decision document presents the second amendment to the Record of Decision (ROD) for Operable Unit (O.U.) #1 at the Bofors-Nobel Site (the "site") in Muskegon, MI, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

BASIS

The decision to amend the ROD is based upon the Administrative Record. Indexes attached to this ROD Amendment identify items that comprise the latest updates to the Administrative Record upon which this amendment of the O.U. #1 Remedial Action is based.

DESCRIPTION OF THE AMENDMENT

On September 17, 1990 a ROD was signed for the O.U. #1 Remedial Action choosing thermal treatment of highly contaminated sludge, disposal of less contaminated soils in an on-site RCRA Subtitle C landfill, and upgrade of existing groundwater extraction and treatment systems. On July 22, 1992 a ROD amendment was signed removing thermal treatment and changing disposal to two on-site RCRA type landfill cells. U.S. EPA in consultation with the State of Michigan issued a remedy re-evaluation on July 16, 1996:

- affirming this remedy as the best alternative under U.S. EPA's evaluation criteria, but
- determining that a Total In-Situ Containment (TIC) remedy proposed by certain potentially responsible parties (PRPs) provided an equivalent approach if implementability and long-term reliability and effectiveness issues could be addressed.

In response to the remedy re-evaluation, the PRPs revised the TIC remedy alternative to address the specific concerns identified, and expressed a commitment to assure successful implementation of the revised TIC remedy. This second ROD amendment is being issued to reflect such new information and:

- replaces excavation and disposal of contaminated source areas in on-site cells with cover and barrier wall containment of the source areas,
- provides for phytoremediation within the barrier wall to enhance immobilization of wastes and control of contaminated groundwater, and promote contaminant treatment and reduction by biological means,
- establishes long term groundwater remediation standards, soil cleanup goals, and requires deed restrictions for the site, and
- continues to require containment and extraction, and treatment of groundwater and long term containment and management of groundwater until groundwater remediation standards are met.

The goal of this second amended remedy is to eliminate unacceptable primary human health risks posed by exposure to contaminated soils and sludge, mitigate environmental threats, and control and ultimately restore contaminated groundwater. This amendment to the O.U. #1 remedy is consistent with past Remedial Actions for this site.

STATUTORY DETERMINATIONS

This second amended remedy is protective of human health and the environment, complies with Federal and State requirements legally applicable or relevant and appropriate to the Remedial Action, and is cost effective. The principal threat wastes will be reliably controlled in place. In addition, the phytoremediation component of the remedy provides treatment of these principal threat wastes consistent with the statutory preference for treatment as a principal element. Thermal treatment was shown not practicable in the 1992 ROD amendment because site soil and sludge consists of mixed waste of widely varying composition and the large waste volume made thermal treatment technology impracticable. This remedy will result in hazardous substances remaining on site, requiring a review every five years after the start of Remedial Action to ensure the selected remedy remains protective of human health and the environment.

The State of Michigan concurs with the second amended remedy put forth in this document.

7/16/97
Date

Wm. E. Muno
William E. Muno, Director
Superfund Division

**THE SECOND AMENDMENT TO THE RECORD OF DECISION FOR O.U. #1;**
**BOFORS-NOBEL SUPERFUND SITE - MUSKEGON, MICHIGAN**

**TABLE OF CONTENTS**

## LIST OF FIGURES, TABLES, AND APPENDICES

## I. INTRODUCTION

The purpose of this document is to explain fundamental changes in the Remedial Action (RA) selected by the U.S. Environmental Protection Agency (U.S. EPA) in the Record of Decision (ROD) signed on September 17, 1990, and amended on July 22, 1992 (collectively, "the ROD as amended") for Operable Unit (O.U.) #1 at the Bofors-Nobel Superfund Site (the "site"). The site is located in the South 1/2 of Section 32, Township 10 North, Range 15 West, at 5307 Evanston Avenue in Egelston Township, Muskegon County, Michigan (see Figures 1 and 2). The remedy selected in the ROD as first amended included excavating and placing contaminated soils and sludge into an on-site RCRA-type landfill with a leachate collection system (the "Landfill Remedy"), and extraction and treatment of contaminated groundwater. It is the excavation and landfilling portion of the remedy that is being changed by this second ROD amendment. U.S. EPA, in consultation with the Michigan Department of Environmental Quality (MDEQ), received new information regarding a viable alternative remedy that provides equivalent protection of human health and the environment and potentially improves cost effectiveness.

A specific remedy proposal (known as the "total in-situ containment" or "TIC" remedy) was obtained after adoption of the O.U. #1 ROD and ROD Amendment and evaluated by U.S. EPA and MDEQ. U.S. EPA has concluded that both the Landfill Remedy and the TIC remedy are appropriate approaches to remediate the site. The TIC remedy proposal, modified as described in this second ROD amendment, provides equivalent containment, potentially with greater cost effectiveness. The TIC remedy also provides for contaminant reduction through phytoremediation within contained areas (phytoremediation is the ability for vegetation to provide treatment by transforming contaminants to more benign substances), groundwater extraction and treatment, attenuation and bio-degradation.

Under CERCLA § 117 and Section 300.435(c)(2)(ii) of the National Contingency Plan (NCP), the lead agency is required to propose an amendment to the ROD ("ROD Amendment") and allow the public the opportunity to comment on the proposed changes if differences in the remedial action alter the basic features of the ROD. A notice of availability of the administrative record and new proposed plan for this second ROD Amendment was published in the Muskegon Chronicle on June 17, 1998, commencing a public comment period from June 15 through July 17, 1998. In addition, a public meeting to discuss the new proposed plan was held on June 24, 1998 at the Egelston Township Hall. U.S. EPA responses to comments received during this period and from the meeting are

contained in a Responsiveness Summary, attached to this ROD Amendment as Appendix B.

U.S. EPA has provided an update to the Administrative Record for the site. This information can be found in greater detail in site-related documents available for review at:

(1) Egelston Township Hall
5428 East Apple Avenue
Muskegon, MI 49442,

(2) Hackley Library
316 West Webster Street
Muskegon, MI 49440, and

(3) U.S. EPA Superfund Division Record Center
77 West Jackson Boulevard - 7th Floor
Chicago, Illinois 60604

The Agencies encourage the public to review these and other documents to gain a better understanding of the site. All comments received as a result of this comment period and summarized and responded to in Appendix B will become part of the Administrative Record for the site.

## I.A. Site History

This 85 acre site is located 6 miles east of downtown Muskegon in Egelston Township, Muskegon County, Michigan, and includes a currently operating specialty chemical production facility and 10 abandoned sludge lagoons (see Figure 3). The southern portion of the site is approximately bounded by Big Black Creek.

Lakeway Chemicals, Inc. ("Lakeway") began producing industrial chemicals at the site in or around 1960. The plant produced alcohol-based detergents, saccharin, pesticides, herbicides, and dye intermediates. Unlined lagoons were used for wastewater and sludge disposal until approximately 1976. Wastes disposed of in the lagoons included iron sludge, iron scale, 3,3'-dichlorobenzidine ("3,3'-DCB") and other organic wastes, zinc oxide waste, wastes generated from spills, calcium sulfate sludge, and detergent wastes. In the 1970s, the State of Michigan discovered many of these contaminants within site groundwater. Releases from the lagoons as well as contaminant concentrations in the groundwater were high enough to severely decrease the amount of surface water life within Big Black Creek, which received the groundwater discharge. In 1976, as a result of enforcement action by the State of Michigan, extraction wells

were installed by Lakeway to capture and contain contaminated groundwater before it reached Big Black Creek. This system of extraction wells has been expanded and continues to operate.

In 1977, Bofors Industries, Inc., a wholly-owned subsidiary of Bofors America, Inc. ("BAI"), acquired title to the site through its merger with Lakeway and continued the operations of the chemical plant. The merged company, Bofors Lakeway, Inc., remained a wholly-owned subsidiary of BAI. BAI in turn was a wholly-owned subsidiary of AB Bofors, which later became Nobel Industries Sweden AB ("Nobel"). In 1981, Bofors Lakeway, Inc. changed its name to Bofors Nobel, Inc. ("BNI"). In December 1985, BNI filed a Chapter 11 case in Bankruptcy Court. On December 6, 1986, BAI transferred ownership of BNI to BAI Holding, Inc., another wholly-owned subsidiary of Nobel. On March 25, 1987, certain assets of BNI were sold under the supervision of the Bankruptcy Court. These assets included the operating plant which was sold to the current owner/operator, Lomac, Inc.

The Michigan Department of Natural Resources (now the MDEQ) began the Remedial Investigation (RI) at the site in March, 1987. The site was placed on the National Priorities List in March, 1989. Two operable units were defined at the site. MDEQ, with review by U.S. EPA, completed the RI for both operable units in the summer of 1989. MDEQ conducted a Feasibility Study (FS) for O.U. #1 concurrently with the RI. The FS was completed in June, 1990. The first operable unit addresses contaminated sludge and soils in the abandoned lagoon area and the groundwater extraction and treatment system. As defined in the ROD, the second operable unit addressed overall groundwater cleanup standards and contaminated soils in the plant area. As part of the fundamental remedy change, this second ROD Amendment for O.U. #1 will establish site wide groundwater remediation goals and remove them from the scope of O.U. #2.

To address soils contamination within O.U. #2, Lomac will submit an Interim Remedial Action Plan to the MDEQ for the plant area soils during Lomac's continued operations. The Interim Remedial Action Plan will be reviewed and approved by the MDEQ in consultation with the U.S. EPA. The U.S. EPA will issue a final O.U. #2 ROD to address a final cleanup action to be implemented at the time when manufacturing in the plant area ceases.

## I.B. Summary of Site Contaminants

### 1. Lagoon Area Soils and Sludge

Table 1 lists contaminants discovered in soil and sludge in the lagoon area of O.U. #1 based on the results of sludge and soil sampling that occurred for the RI and shown in the original 1990 ROD. The compounds aniline, azobenzene, benzene, benzidine, 3,3'-dichlorobenzidine, and methylene chloride have been identified as contaminants of concern in the baseline risk assessment for the site. Table 1 includes clean up criteria under Part 201 (Environmental Remediation) of Michigan Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended ("Part 201") for human direct contact with surface soil in an industrial exposure scenario. These are the levels that must be met and maintained by the O.U. #1 lagoon area cover to ensure that there is no unacceptable human health risk to an individual working on the site within a controlled work environment. Part 201 soil cleanup criteria for protection of groundwater are included in Table 1. These levels must be reached as one of the conditions necessary to discontinue the containment component of the TIC remedy. These cleanup criteria will ensure that groundwater is protected under a reasonable future land use scenario and for discharges to surface water in the event that containment and institutional controls are no longer maintained. If these criteria and the groundwater criteria described in Section I.B.2 of this ROD Amendment are met and maintained at all points of compliance, containment and the associated institutional controls will no longer be necessary. Threats posed by contamination through human exposure pathways are discussed in Section I.C and discussion of remedy cleanup goals and criteria is included in Section I.E of this ROD Amendment.

### 2. Site Groundwater

Table 2 lists the maximum concentration of contaminants found in groundwater during sampling within the 1990 RI/FS and the Remedial Design for the Landfill Remedy. Table 2 includes clean up criteria under Part 201 (Environmental Remediation) of Michigan Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended ("Part 201") for human consumption of groundwater on-site under future reasonable land use scenarios. An ultimate goal of the TIC remedy is to achieve these criteria or Federal maximum contaminant levels (MCLs), whichever are more stringent. For those listed contaminants that have Federal MCLs, the Part 201 cleanup criterion is the same as the MCL for that contaminant. Within the O.U. #1 area, the clean

up criteria for future industrial land use are applicable unless appropriate deed restrictions can not be obtained, in which case criteria for future residential land use would apply. To achieve successful completion, this second amended remedy must ensure that these criteria are met and maintained throughout the affected groundwater area. Unless and until final groundwater cleanup criteria are met, contaminated groundwater will be contained by use of the barrier wall and groundwater extraction to ensure that the remedy protects Big Black Creek. To ensure that the remedy protects Big Black Creek, Table 2 lists Groundwater - Surface Water Interface (GSI) criteria that represent contaminant concentrations in groundwater which, if not exceeded, are protective of a surface water body that receives such contaminated groundwater discharge. An ultimate goal of the TIC remedy is to achieve these criteria to insure that no unacceptable discharge to surface water occurs in the event that containment and institutional controls are no longer maintained. Threats posed by contamination through human exposure pathways are discussed in Section I.C and discussion of remedy cleanup goals is included in Section I.E of this ROD Amendment.

### 3. Other Potentially Affected Media

The 1990 ROD identified that there was a potential for contaminants to be released from lagoon area sludge and soil by particulate or volatile emissions. Air sampling both up gradient and down gradient of the site conducted during the RI and later during RD of the Landfill Remedy indicated that, although there were some detections of contaminants in the air, it was not attributable to lagoon area sludge or soil. Documents containing both RI and RD results have been included and are available for review in the Administrative Record for the site.

As noted in the 1990 ROD, the primary route of contaminant release to Big Black Creek appears to be from discharge of contaminated groundwater to surface water. Because of the operation of the groundwater extraction wells, sampling and analysis conducted during the RI did not identify any concern with contamination in Big Black Creek surface water or sediment. In addition, the requirement for and continued operation of a groundwater containment, extraction, and treatment system ensures interception of contaminated groundwater before reaching Big Black Creek.

### 4. Current Status of Site Contaminants

To indicate the current status of contaminants in the lagoon area, Table 3 provides a limited comparison of information in

Tables 1 and 2 with recent (mid-1997) sampling and analysis of site groundwater and soil. Table 3 suggests that contamination in some areas of the O.U. #1 lagoon area (which has not been disturbed since the mid-1970s) has somewhat diminished through natural means. There still exists, however, contamination at high enough concentrations to require immobilization of, and prevention of contact with, this sludge and soil. Also, control of contaminated groundwater is necessary by containment, extraction, and treatment before discharge. When compared with cleanup criteria listed in Table 1 and 2, contaminant concentrations for some contaminants continue to exceed State of Michigan cleanup criteria. Design and construction of the TIC remedy will be based on the cleanup criteria presented in Tables 1 and 2 and specific performance standards.

## I.C. Summary of Site Risks

Table 4 lists the risk identified in the 1990 ROD associated with the contaminants found in the O.U. #1 lagoon area. To assess any possible reduction since 1990 in contaminant concentrations and risk, U.S. EPA, with consultation by MDEQ and the PRPs, investigated the risk currently present in the lagoon area using current site conditions. It has been confirmed that there still remains significant risk at the site that requires Remedial Action. Documents summarizing this risk confirmation have been included in the Administrative Record for the site.

Risk associated with ingestion of and/or contact with surface water cited in the 1990 ROD ranged from $1 \times 10^{-2}$ to $3.4 \times 10^{-7}$, depending upon exposure to contaminated groundwater that discharged to Big Black Creek. Risk associated with surface water pathways are being addressed in this ROD Amendment by the requirement for compliance with State of Michigan GSI cleanup criteria, as discussed in Section I.B.2 and I.E of this ROD Amendment.

When the Hazard Index (HI) is greater than 1, there is a potential for health problems such as damage to vital organs, birth defects, and anemia and other blood disorders. A $1x10^{-6}$ cancer risk value corresponds to a 1 in 1,000,000 chance that an individual develops cancer as a result of exposure to these concentrations of contaminants over a period of 70 years. Similarly, $10^{-5}$ corresponds to a 1 in 100,000 chance, $1x10^{-4}$, 1 in 10,000, and so on.

With implementation of deed restrictions, this ROD Amendment requires a level of protectiveness for the O.U. #1 lagoon areas and site groundwater not discharging to Big Black Creek

consistent with a future industrial land use scenario. Current zoning of the site, deed restrictions, and site security will increase the likelihood that future exposure to the site will only be through a controlled industrial scenario, in accordance with reasonable future land use for the site. Fundamental components of the TIC remedy include a lagoon area cover that must ensure prevention of contact with contaminated soil and sludge and associated emissions, a groundwater containment and extraction system that ensures prevention of contaminated groundwater from entering the Big Black Creek system, and a long term commitment to ensure that operation and maintenance of these mitigative measures continues for a time period adequate to ensure all Remedial Objectives are met and maintained as long as necessary.

## I.D. Remedy Decisions & Implementation of Original Remedy

The O.U. #1 ROD, as originally amended, selected a remedy which called for groundwater extraction and treatment and the excavation and landfilling of contaminated lagoon area soils and sludge (Landfill Remedy). This remedy provided for:

- groundwater containment, through the use of extraction wells, to prevent discharge of contaminated groundwater to Big Black Creek;
- reduction of contaminants through groundwater treatment; and
- secure containment of the contaminated soils and sludge in an on-site RCRA type landfill.

U.S. EPA intended for the existing extraction system to continue containing the contaminated groundwater (preventing off-site migration of the contaminants) and extracting groundwater to reduce the concentrations of contaminants until acceptable levels were reached. The O.U. #1 ROD, as amended, also required the existing extraction system to be upgraded, and required the construction of a plant to treat the extracted groundwater prior to discharge into Big Black Creek.

As part of the remedy for O.U. #1, a groundwater treatment plant (GWTP) was designed by the U.S. Army Corps of Engineers (USACE) from March 1991 to May 1992. Construction of the GWTP took place from October 1992 to June 1994 and the GWTP began treating contaminated groundwater in September 1994. The capacity of the GWTP was designed to treat the maximum possible flow rate expected from the Landfill Remedy. The GWTP discharges to Big Black Creek, and is successful in meeting surface water discharge standards established by the MDEQ.

The Remedial Design (RD) for the landfill to contain soils and sludge of O.U. #1, including hot spots of O.U. #2, was completed by USACE under agreement with the U.S. EPA. In March 1993, the Landfill Remedy RD was approved by U.S. EPA. U.S. EPA delayed landfill construction in order to re-evaluate O.U. #1 remediation goals and consider the TIC remedy made available after the landfill design documents were completed.

On July 16, 1996, U.S. EPA (with the concurrence of the State) issued a remedy re-evaluation document, notice was published in a major local newspaper of general circulation, and opportunity for written comments was provided until August 13, 1996. Following issuance of the remedy re-evaluation document, U.S. EPA, the State of Michigan, and PRPs identified for the site continued technical discussions, which then led to refinements of the TIC remedy as described here and in documents located in the Administrative Record. Re-evaluation was performed primarily because: (1) since the time of U.S. EPA's remedy decision, more information had been developed on barrier wall technology (which is included as part of the TIC remedy proposal); and (2) the timing of U.S. EPA's identification of PRPs had not allowed them a full opportunity to comment on the prior remedy decisions.

In the re-evaluation document, U.S. EPA established that the TIC remedy provided an equivalent approach if implementability and long-term reliability and effectiveness issues could be addressed. To that end, between July and September 1997 the PRP Group researched and investigated the site and refined its TIC proposal to address these issues. On September 9, 1997, the PRP Group issued a Technical Memorandum that addresses implementability issues and (along with the necessary legal agreement) provides the required modifications and long term commitment for a TIC remedy. These documents provide the basis for this ROD Amendment.

## I.E Remedy Goals

Table 1 includes criteria for human direct contact with surface soil for a future industrial land use scenario. These are the levels that must be met and maintained to ensure that there are no unacceptable human health risks to an individual working on the site within a controlled work environment or otherwise present on the site. These direct contact criteria will be met by the O.U. #1 lagoon area cover that will be installed as part of the TIC remedy and is necessary for the containment of wastes in place.

Table 1 lists soil cleanup criteria intended to ensure that contaminants in soil will not leach to groundwater at unacceptable levels. These criteria are the level of contamination in soil that prevents unacceptable levels of groundwater contamination for a reasonable future land use scenario. Table 1 lists soil cleanup criteria goals for both future residential and industrial land use scenarios. Successful achievement of these criteria and the appropriate Part 201 groundwater cleanup criteria is necessary to eliminate the need for maintenance of containment. One ultimate goal of groundwater extraction and the treatment provided by this remedy is the reduction of the on-site contaminants listed in Table 1 to cleanup criteria associated with a future industrial land use scenario, or, if appropriate deed restrictions can not be obtained, a future residential land use scenario. Another goal of the groundwater extraction and the treatment provided by this remedy is the reduction of contamination to those cleanup criteria protective of surface water.

Table 2 lists GSI criteria that must be met and maintained for the containment component of the TIC remedy to ensure protection of Big Black Creek. Table 2 also lists cleanup criteria for groundwater that are the goals of the combination of the treatment provided by phytoremediation and the groundwater extraction and treatment system(s). Table 2 lists groundwater cleanup criteria for both residential and industrial future land use scenarios. Specifically, one ultimate cleanup goal is the reduction of contaminants throughout affected groundwater to these criteria or Federal maximum contaminant levels (MCLs), whichever are more stringent. Achievement of GSI standards will also accomplish another ultimate goal, the reduction of contaminants to cleanup criteria protective of surface water. For those listed contaminants that have Federal MCLs, the Part 201 cleanup criterion is the same as the MCL for that contaminant. These cleanup goals are the levels acceptable for human consumption within a future industrial land use scenario, or, if appropriate deed restrictions can not be obtained, to levels acceptable for human consumption within a future residential land use scenario. If these soil and groundwater cleanup goals are met and maintained the containment portion of the remedy would no longer be necessary.

This TIC remedy provides for containment of sludge, soils, and groundwater as the base component to immediately address the threat from contamination in the lagoon area and in site wide groundwater. In addition to containment, the second amended remedy provides for reduction of soil and groundwater contamination levels through treatment provided by

phytoremediation, groundwater extraction and treatment, and attenuation and bio-degradation. If treatment and other remedy components reduce contamination in sludge and soils, and groundwater to cleanup goals, then the containment provided by the TIC remedy will no longer be necessary.

## I.F. Remedial Action Objectives

The Remedial Action Objectives (RAOs) for this remedy to ensure containment are as follows:

1. Containment of lagoon sludge and soils to prevent on-site[1] exposure to hazardous substances at concentrations that pose an unacceptable risk to human receptors under industrial land use scenarios via the following routes of exposure: (a) direct contact; (b) inhalation from volatization to indoor air; (c) inhalation from volatization to ambient air; (d) drinking water use of aquifer; (e) groundwater contact; and (f) surface water contact. Containment of lagoon sludge and soils to prevent on-site exposure to hazardous substances at concentrations that pose an unacceptable risk to environmental receptors via the following routes of exposure and migration pathways: (a) contact with contaminants present in surface soils, plants, water or air on-site; (b) groundwater impacts on surface water; and (c) soil runoff impacts on surface water.

2. Containment of lagoon sludge and soils to prevent off-site migration of contaminants to air, soil or groundwater at concentrations that would pose an unacceptable risk to human and/or environmental receptors; and

3. Containment of groundwater to prevent migration of contaminants at concentrations that would pose an unacceptable risk to human and/or environmental receptors off-site including to Big Black Creek and to the on-site wetlands between Big Black Creek and the barrier wall.

In order to ensure these objectives are met and maintained, the remedy will include:

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[1] For purposes of this ROD Amendment, 'on-site' means all property within the former Bofors-Nobel property boundaries except for any property to the South of the northern shore of Big Black Creek. For purposes of this ROD Amendment, 'off-site' means any property beyond the former Bofors-Nobel property boundaries to the North, East and West, and beyond the northern shore of Big Black Creek to the South.

- measurement of the effectiveness of containment systems including measurement of the reduction in contaminant concentrations; and

- operation and maintenance of containment systems until such time as it is determined that continued operation of containment is unnecessary.

This TIC remedy will comply with all State and Federal Applicable or Relevant and Appropriate Requirements (ARARs).

## II. REASONS FOR ISSUING THE ROD AMENDMENT - Supporting Information for the Fundamental Change

The first amended ROD concluded that a thermal treatment remedy for O.U.#1 was not cost effective due to the excessive volume of soil and sludge requiring remediation. That ROD estimated that the combined present worth of capital and O&M for thermal treatment of soil and sludge and on-site landfilling was approximately $ 71,000,000. The first ROD Amendment provided a more accurate excavation volume and increased this estimate to approximately $ 221,000,000 (net present worth of capital and O&M). That ROD Amendment further concluded that containment of contaminated soil using a landfill would provide a reduction of risk equivalent to that of treatment at a capital cost of approximately $ 46,000,000 (not including groundwater extraction and treatment). The TIC remedy established by this ROD Amendment will provide containment and reduction of risk equivalent to that of the Landfill Remedy, but at a reduced net present worth cost range of approximately $ 10,000,000 to $ 40,000,000 (including a revised groundwater extraction and treatment system).

The Landfill Remedy intended to address site contamination by first isolating the contamination source (soils and sludge) from site groundwater and then physically removing contaminated groundwater by pumping and treating. By isolating source material and extracting and treating contaminated groundwater, the Landfill Remedy could ultimately achieve acceptable groundwater cleanup limits. In the Feasibility Study, below grade barrier wall remedies were considered unacceptable because source material remains in contact with the groundwater resulting in the potential need for perpetual groundwater extraction. In addition, landfill technology was selected instead of a barrier wall due to the uncertainties regarding containment effectiveness of barrier walls.

In its re-evaluation, U.S. EPA concluded that both the Landfill Remedy and the TIC remedy (if properly modified) provide

equivalent degrees of risk reduction if adequate long-term assurances are in place for the TIC. The TIC remedy, however, provides the greatest potential for cost effectiveness and contains treatment components that allow for site remediation by more natural mechanisms and may allow for potential further treatment. With the extensive excavation work required, the Landfill Remedy poses more potential for short term risks than the TIC remedy (approximately 50,000 cubic yards would be excavated and/or shifted for the TIC, compared to roughly 800,000 cubic yards for the landfill). The TIC remedy presents a scenario whereby Remedial Action Objectives may be reached through more natural means at a potentially significant cost savings. The TIC also offers treatment which may eventually permit the containment portion of the remedy to be discontinued if compliance with all cleanup goals at the site is demonstrated.

The presence of the existing groundwater extraction, containment, and treatment system that has already proven itself through 20 years of operation affords the opportunity for implementation of this amended remedy. It also allows for the installation and maturation of vegetative remedy components without increasing human risk or threatening Big Black Creek. In the event of failure of the barrier wall portion of the remedy, re-use of existing wells or installation of new extraction wells can be easily implemented.

The TIC remedy represents a variation on, and an expansion of, the slurry wall containment option that was evaluated in the FS. Since that time, experience with barrier wall construction has increased, and, consequently, some uncertainties have decreased. U.S. EPA agreed to re-evaluate the remedy to consider new information regarding slurry wall technology not available during the FS. The TIC remedy is similar in principle to those slurry wall options presented in the FS, but has been modified to include other components.

The use of a natural vegetative system as an additional part of the remedy will also assist in the immobilization of contaminants, and secondarily may synthesize or trap groundwater contaminants either through internal processing or natural uptake. It is anticipated that the vegetative portion of the TIC remedy will have a root mass below the soil layer containing the highest contaminant concentrations (see Figure 5). This should serve as a natural supplement to the containment cell created by the constructed barrier wall and O.U. #1 lagoon area cover.

Scientific literature suggests that certain vegetative species are able to survive within contaminated areas. Water will move

through the vegetation by natural osmotic mechanisms assisting in hydrologic control of the groundwater and providing an enhancement to the barrier wall. Vegetation promotes microbial activity, enhancing contaminant attenuation through biological mechanisms. The amount of biofouling observed in the on site extraction wells indicates that biological activity is taking place at the site.

## III. DESCRIPTION OF THE FUNDAMENTAL REMEDY CHANGE

### Total In-Situ Containment (TIC) Remedy

The fundamental change to the O.U. #1 remedy is the method by which containment of contaminated O.U. #1 lagoon area soils, sludge, and groundwater is achieved, and the addition of the treatment component provided by phytoremediation. Current updates to the Administrative Record include summary documents presenting the characteristics of the TIC remedy. Figures 4,5 and 6 depict components of this amended remedy. The TIC remedy will consist of the following minimum components:

- A below grade barrier wall to a depth of approximately 75 to 100 feet around areas of soil contamination, which may be keyed into a confining layer.

- A cover designed to prevent unacceptable exposure to contaminated soils and sludge and any associated emissions.

- Installation of vegetative species to assist in immobilization of soils and provide enhancement of natural mechanisms for reduction of contaminant concentrations.

- Containment and collection of contaminated groundwater, using the barrier wall and other acceptable collection methods, including extraction wells. Construction activity for the barrier wall, cover, vegetation installation, and groundwater containment/collection will include restoration of wetlands that may be disturbed by the construction, and may create new wetland areas.

- Appropriate treatment of collected and extracted groundwater at the GWTP, or an alternate facility that provides an equivalent level of effectiveness.

- Monitoring programs to assess the containment effectiveness of the barrier wall and groundwater collection and extraction system, and to assess the reduction of contaminant concentrations in soil, sludge and groundwater.

- Establishing appropriate institutional controls (such as deed restrictions) to preclude unacceptable construction and use of wells in areas where contamination remains, and to ensure that future land use is compatible with the remedy.

- Long term operation and maintenance (O&M) to ensure the effectiveness of containment and groundwater extraction within areas of known contamination, including newly vegetated areas.

- Contingent Remedial Actions in the event remedy components fail to meet and maintain performance standards.

**III.A Barrier Wall**

To prevent untreated site groundwater from discharging directly to Big Black Creek or from expanding laterally beyond its present boundaries, a barrier wall will be installed to a depth that will ensure retardation of lateral movement of contaminated site groundwater. The barrier wall may extend to an approximate depth between 75 and 100 feet, depending on specific depths of the underlying clay layer. The estimated length of the slurry wall is approximately 2700 linear feet which is the approximate total of the southern, eastern, and western perimeters of the lagoon area. The intent of this barrier wall is mainly to contain the maximum possible volume of contaminated soils and sludge (the waste mass would remain in place) and provide lateral retardation of groundwater flow. The barrier wall will also assist in capture and/or containment of groundwater contamination located to the north of the lagoon area, including plant site areas. The specific composition, location, depth and other details of the barrier wall will be defined during the Remedial Design. The wall may be constructed of chemically compatible, low permeability material, possibly consisting of a mixture of bentonite clay, native soils, and water, or, for some portions of the wall, grouted steel sheet piling, or a combination of both. Alternative materials and/or construction techniques may be investigated and identified in the Remedial Design.

**III.B Surface Area Cleanup, Civil and Earthwork**

Sludge within the O.U. #1 lagoon areas will be excavated, graded, or relocated in nearby areas and/or stabilized if necessary to provide a sound foundation for placement of cover material. Any debris in the O.U. #1 lagoon area will either be consolidated under the cover, or characterized and disposed of off-site in accordance with all Federal and State ARARs. If necessary, earthwork may include targeted limited excavation of portions of

the lagoon area to assist in the installation and/or operation of the barrier wall, lagoon area cover, groundwater containment and extraction and vegetative treatment portions of the TIC remedy. Details of the scope of this portion of the remedy will be developed during the Remedial Design.

### III.C O.U. #1 Lagoon Area Cover

As part of this remedy, the O.U. #1 lagoon area will be covered to eliminate risks associated with exposure to O.U. #1 soils and sludge, including any risks associated with possible emission of contaminants from soil and sludge. The O.U. #1 lagoon area cover will be constructed over the soil and sludge contamination that constitutes unacceptable risk through relevant exposure routes. The cover will reduce, but not eliminate, infiltration of precipitation through the waste mass. The vegetative component of this remedy requires that the area cover be sufficiently permeable to allow for plant growth. The vegetation will reduce erosion, stabilize the cover, and enhance the aesthetics of the area. Design and construction details for the O.U. #1 lagoon area cover will be developed during the RD but will be based on elimination of exposure pathways that may result in unacceptable risk in accordance with ARARs.

Use of a permeable cover will allow precipitation to percolate through the waste mass and may provide some flushing of contaminants from contaminated soils and sludge into groundwater underneath. Infiltration will be allowed because of the expected groundwater capture provided by the barrier wall and extraction. This flushing of contaminants into ground water will occur while the treatment provided by phytoremediation is occurring and the vegetative components of the TIC remedy are maturing. Contaminants that leach into groundwater would be extracted and treated before discharge to surface water. Over the past twenty years, this type of containment has been successful at this site.

The TIC remedy, including any necessary Contingent Remedial Actions, is expected to comply with all substantive requirements of the identified State and Federal ARARs. Wastes that were deposited in the lagoons are by-products of specialty chemical production that occurred on site before the enactment of RCRA. U.S. EPA determined that RCRA and State landfill cap standards were relevant and appropriate requirements for the Landfill Remedy. Because the TIC remedy has different objectives, including movement and capture of groundwater within the source area, and treatment of waste using phytoremediation, RCRA and State landfill cap standards are not ARARs for the lagoon area cover portion of the TIC remedy. In the event a TIC cover

upgrade is later required as a Contingent Remedial Action, RCRA and Part 111 of NREPA may be ARARs for that upgrade. These standards would be ARARs for any excavation activity. In the event that surface cleanup phase of the remedy requires some excavation and off-site disposal, the excavated material shall be characterized, manifested, and disposed of in accordance with RCRA and parallel State requirements.

## III.D Vegetation Installation and Wetland Enhancement

As an enhancement to the groundwater, soil, and sludge containment provided by the barrier wall, various vegetative species will be planted within the contained areas of the TIC. These plant species will immobilize contaminants, serve to enhance groundwater containment, and provide treatment by phytoremediation. Available literature indicates that plant species have the capability to transform organic contaminants to more benign compounds. The literature further documents that plant roots provide a medium under which microorganisms can flourish, and natural destruction of organic contaminants can occur. As part of the TIC remedy, degradation of the sludge and contaminated soils will be assessed and studies regarding phytoremediation will be incorporated as appropriate into the Remedial Design. Literature suggests that for the nature and extent of contamination present at the site, treatment mechanisms provided by the remedy may reduce site contamination to levels that allow termination of the TIC remedy within an approximate time of 30 to 70 years, with the most appreciable reduction occurring in the initial 20 years. In addition, the biological fouling of existing extraction wells suggests that there is naturally occurring microbial activity on groundwater contaminants. These combined mechanisms contribute to the reduction of contaminants in both groundwater and soils.

Figures 4 and 5 depict the proposed installation layout for TIC remedy vegetation. Four distinct vegetation areas (noted as Areas A,B,C,D) have been proposed. Vegetation will be monitored as needed to assess its success in immobilizing and fostering destruction of contamination and to assure that contamination uptake into the vegetation does not create unacceptable risks.

## III.E Groundwater Containment, Extraction, and Treatment

A network of extraction wells similar to the current system would have provided containment of contaminated site groundwater for the Landfill Remedy. In the TIC remedy, groundwater containment will be provided primarily by the barrier wall, which will re-direct natural groundwater flow towards a vegetated area

constructed within the barrier wall boundaries. The groundwater will discharge to the surface in the wetland where it is anticipated that the contaminants of concern will bind to the humic soils in the wetland, undergo photolysis or biodegrade.

The surface water from this vegetated area will flow to a central weir and sump collection point. The collected water will be sampled and analyzed before determining its disposition. If contaminants in collected water meet appropriate standards, it may be discharged to the creek or the existing wetland outside the barrier wall. The discharge system may be designed such that water that meets appropriate standards is recycled back into vegetated or wetland areas within the barrier wall. Collection, extraction, treatment, and discharge of any water will comply with all ARARs.

If groundwater contaminants exceed standards, the collected groundwater will be directed towards a treatment facility. Extracted groundwater may be treated, as necessary, at the existing groundwater treatment plant. The feasibility of alternate groundwater treatment facilities or further optimization of the existing GWTP will be investigated during the Remedial Design.

In the event the vegetation and the barrier wall can not provide adequate hydrologic control of contaminated groundwater the extraction system may be enhanced. The enhanced groundwater extraction system may include the use of existing extraction wells inside the barrier wall and/or the addition of new extraction wells inside and/or outside of the barrier wall as needed to ensure containment.

To control contaminated groundwater that will remain outside the barrier wall, a groundwater extraction system will be installed prior to or concurrent with construction of the barrier wall. This extraction system will be operated as necessary to prevent discharge of contaminated groundwater exceeding performance standards to Big Black Creek and adjacent wetlands before, during, and after TIC remedy construction activities.

### III.F Monitoring Programs

In order to evaluate and confirm that the performance of the TIC remedy remains protective of human health and the environment, a monitoring program for the sampling and analysis of O.U. #1 groundwater will be developed during the Remedial Design. Groundwater monitoring will need to demonstrate that the remedy successfully prevents migration of contaminants at concentrations

that would pose an unacceptable risk to human and/or environmental receptors off-site or to Big Black Creek and to the wetlands between Big Black Creek and the barrier wall. The points of compliance will be established at Big Black Creek and at the property boundary. This will be accomplished through the use of a combination of new and existing monitoring wells, located within and outside the barrier wall. Sentinel wells will be installed between the southern end of the barrier wall and the Creek, and along the sides of the barrier wall to identify any contamination at levels above cleanup standards that indicate any failure or potential failure to satisfy Remedial Action Objectives including compliance with ARARs. The degree, frequency, procedures, and scope of the groundwater monitoring program(s), including location and construction details of any new wells, and the long term requirements for groundwater monitoring, will be developed during the TIC Remedial Design. This groundwater monitoring will be in addition to sampling and analysis that will be required for development of the TIC Remedial Design and groundwater monitoring necessary to assess progress toward achievement of groundwater cleanup goals.

Sampling and analysis of O.U. #1 soils and sludge will be required to determine if final cleanup goals are achieved or to determine the presence and degree of the reduction in contaminant concentrations. The necessity, degree, frequency, procedures, and scope of any soil and sludge monitoring program(s), and long term requirements for soils and sludge monitoring, will be determined during the TIC Remedial Design.

To determine the effect of the vegetative components of the TIC remedy on the new and existing ecosystem present in O.U. #1 areas, some degree of monitoring of plant and animal life forms may be required. It is anticipated that there may be a certain amount of uptake and retention of contaminants by vegetation which may affect species potentially using the vegetation for food and inhabitation. Available phytoremediation laboratory and field information and the recommendations of reviewing ecologists suggests that, if TIC remedy vegetation absorbs contamination, it will be stored within the wood and/or transformed by plant metabolic processes. Vegetative species planted as part of this remedy may internally synthesize contaminant compounds, which might necessitate sampling such species to monitor these changes. Such monitoring may be a requirement for compliance with ARARs associated with protection of wildlife and ecology that are identified for the site and summarized in Appendix A to this ROD Amendment. The necessity, degree, frequency, procedures, and scope of any ecological and/or biological monitoring program(s), will be determined during the TIC Remedial Design and will be

developed in concert with other monitoring programs required for this remedy.

Air monitoring will be required during construction of the TIC remedy to ensure compliance with Federal and State ARARs. Monitoring may entail continuous atmospheric sampling and analysis to ensure that no particulate or vapor emissions at unacceptable levels travel beyond the site perimeter. For safety purposes, local air monitoring at the point of work will be performed for the safety of both project workers and nearby passers by, and will serve as a preliminary indicator before reaching site perimeter sampling points.

In the event it is determined that alternate facilities are utilized for groundwater treatment, any new groundwater treatment facility may require regular air monitoring for discharges. The existing GWTP has already been assessed for such requirements and currently follows procedures as administered by the State. The necessity, degree, frequency, procedures, and scope of any air monitoring program(s), will be determined during the TIC Remedial Design, and will be developed in concert with other monitoring programs required for this remedy.

State of Michigan GSI criteria will be used to determine whether the remedy protects Big Black Creek. Surface water and sediment were not identified as a concern in the 1990 ROD provided capture of contaminated site groundwater continues, and/or exposure to contaminated site groundwater discharging to Big Black Creek is prevented. In order to ensure compliance with these GSI criteria, and as part of required State of Michigan surface water protection procedures, it may be necessary to perform sampling and analysis of Big Black Creek water and sediment. The necessity, degree, frequency, procedures, and scope of any surface water and/or sediment monitoring program(s), will be determined during the TIC Remedial Design, and will be developed in concert with other monitoring programs required for this remedy.

### III.G Deed Restrictions

As part of the Remedial Action, institutional controls and deed restrictions will be implemented on the O.U. #1 area of the site. At a minimum, such deed restrictions and institutional controls shall include a restriction on the use of contaminated groundwater or soil, prohibition of any activities which may damage any remedial action component or otherwise impair the effectiveness of any work to be performed except with prior written approval of the U.S. EPA. The reasonably anticipated future land use of the site

is industrial. Current zoning established by Egelston Township requires that the site can only be used for industrial use. Implementation of deed restrictions will insure that use of the site property remains industrial. Land use restrictions or deed restrictions can only be implemented by a person who controls a property or a property owner. Water use restrictions will be implemented with these deed restrictions, so that contact with site related contamination would be restricted as a supplement to physical constraints. Provision has been made in the cost estimate included in this ROD Amendment for the implementation of deed restrictions.

## III.H Contingent Remedial Actions

It is anticipated that a phased approach for TIC remedy construction will be implemented. This approach will allow the different phases of the remedy to be installed, monitored and its effectiveness measured. As part of the RD, a series of Contingent Remedial Actions (CRAs) will be refined and will be implemented subsequent to initial construction activity if any component of the TIC remedy is ineffective.

In the event performance standards (which are included as Tables 1 and 2) are not met, the cause(s) of the failure shall be identified and CRAs shall be implemented. The CRAs that may be implemented in the event of a performance standard exceedance or potential exceedance include the following: (1) expedited monitoring to confirm the characteristics and extent of an exceedance; (2) upgrade and/or repair of the groundwater extraction system (including installation of new extraction well if necessary) within or down-gradient of the barrier wall; (3) implementing alternate or additional groundwater treatment technology or using an alternate facility; (4) supplemental groundwater extraction and treatment until such time that CRAs are not needed; (5) re-planting of vegetation (including introduction of additional nutrients and/or provision for replacement of dead vegetation, or selection of alternate species); (6) repair or upgrade of the protectiveness and/or impermeability of the O.U. #1 lagoon area cover; (7) repair or replacement of the barrier wall; and (8) excavation and disposal of targeted contaminated material. Excavation would only be implemented if it were determined that this remedy could not securely contain the targeted wastes in place, or if excavation of limited areas will produce or expedite final achievement of all performance standards.

In addition, if field visual inspections show adverse ecological effects on ecological assessment endpoints indicative of unacceptable acute toxic effects or unacceptable observable

chronic effects; or if field measurement shows adverse ecological effects on ecological assessment endpoints indicative of other unacceptable chronic effects; then contingent ecological investigations will be implemented which will include an analysis of the cause. Appropriate CRAs for these adverse ecological effects (such as upgrade of the O.U. #1 lagoon area cover or enhanced access restrictions and/or engineered controls) could then be developed and implemented.

Details of identification and implementation of CRAs shall be developed and included in the Remedial Design.

### III.I Operation and Maintenance (O&M)

The TIC remedy intends to provide containment of contaminated material until such time as O.U. #1 contamination levels have been reduced by the remedy and reach acceptable cleanup criteria. In addition to defined Contingent Remedial Actions, there are tasks that will be required for O&M of the TIC remedy, as well as a commitment for a period of time estimated at a minimum of 30 to 50 years. The following minimum components, described here in general terms, will be required for O&M:

1. The success of the containment provided by the TIC remedy will be assessed through sampling and analysis of all contaminated media, including groundwater, soil and sludge and (potentially) surface water and sediments as defined in monitoring programs established during the TIC Remedial Design. In addition such monitoring will provide information regarding the degree of treatment and degradation of contaminants.

2. Sampling and analysis of ecosystem indicators, such as vegetative and animal life forms, if determined necessary and as defined in monitoring programs established during the Remedial Design.

3. Provision for O&M of the existing GWTP constructed by U.S.EPA is required until such time as any alternate groundwater treatment can be identified, constructed, and started up. In the event that there are no acceptable alternatives, use of the GWTP may be continued.

4. Upkeep, monitoring, and routine inspection of the vegetative portion of the TIC remedy. If determined to be necessary after planting, nutrients may be introduced at a frequency initially established by the TIC remedy Remedial Design, but may be modified as necessary based on vegetative development.

5. Regular inspections of the O.U. #1 lagoon area cover. This is necessary to assure the protectiveness of the cover and prevent disturbance and exposure to contaminated soils remaining underneath the cover and to assess whether adverse ecological effects are occurring at the site.

6. Based on vegetative development and the propensity of contaminant uptake, a potential O&M task may include harvesting, proper off-site disposal, and re-planting of vegetation. The necessity of this O&M task is highly dependent on whether contaminants are synthesized or accumulated by vegetative species, and the degree and nature of contaminant fate within the plant species. The necessity of this O&M task will be determined after the TIC remedy is installed and allowed to operate for a reasonable time period and would be based on assessments of the remedy's overall effectiveness. Serious adverse ecological effects that can not be remedied through O&M measures will require Contingent Remedial Actions of the same sort required for failure to meet standards for soil.

7. Upkeep of any additional extraction system installed to augment groundwater containment provided by the barrier wall. This O&M component may require such tasks as repair, cleaning, and replacement of extraction wells, both existing and installed as part of the TIC remedy.

8. Upkeep of any new treatment facility, including general housekeeping, monitoring for process efficiency, repair, replacement, and preventive maintenance of process equipment such as pumps, tanks, and contaminant treatment components.

## III.J Site Remediation Goals and Operable Unit #2

The previous ROD Amendment deferred site-wide groundwater remediation goals for the ROD that is required for O.U. #2. Issuance of a ROD for O.U. #2 has been delayed in order to allow for re-evaluation of the decisions regarding O.U. #1 lagoon area contamination. O.U. #2 was delineated to segregate soil and groundwater contamination existing underneath the chemical production area of the site. The contamination in O.U. #2 soils is a potential source of groundwater contamination. The barrier wall, however, will also contain this contaminated groundwater. In order to achieve site wide remediation goals, the O.U. #2 soils may eventually need to be removed or otherwise addressed by other remediation technology. Complete delineation, evaluation and remediation of O.U. #2 soils, however, can not occur until the Lomac production activity is discontinued and buildings are

removed. U.S. EPA will issue a final ROD for the O.U. #2 area that will define a final remedy to be implemented after production activity in the O.U. #2 area ceases.

The final O.U. #2 ROD will address the process for evaluating further data that may be required with respect to:

- contamination in and under on-site buildings in O.U. #2 areas;
- residual contamination on site in O.U. #2 areas;
- the necessity, cost, and feasibility of building demolition;
- the need for vegetative or other cover compatible with the O.U. #1 ROD, as amended; and
- disposal options and requirements for remaining contaminated media.

An interim action will be performed on O.U. #2 to prevent unacceptable exposure to contaminants. This interim action, which may include capping and groundwater containment and/or extraction will be performed under the authority of the State of Michigan. Through the five-year review process, U.S. EPA will evaluate the effectiveness of the TIC remedy and consider its effectiveness and relationship to the O.U. #2 interim action.

## IV. NINE CRITERIA EVALUATION OF THE TIC REMEDY

### IV.A THE NINE CRITERIA

**THRESHOLD CRITERIA**

1. **Overall protection of human health and the environment** determines whether the alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.

2. **Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)** evaluates whether the alternative meets Federal and State environmental statutes, regulations, and other requirements that pertain to the site.

**PRIMARY BALANCING CRITERIA**

3. **Long-term effectiveness and permanence** considers the ability of the alternative to protect human health and the environment over time and the reliability of such protection, including the degree of certainty that the alternative will prove successful.

4. **Reduction of contaminant toxicity, mobility, or volume through treatment** evaluates the alternative's effectiveness in reduction of the harmful effects of principal contaminants, reduction of the contaminants' ability to move in the environment, and the reduction in amount of contamination present.

5. **Short-term effectiveness** considers the length of time needed to implement the alternative and the risks the alternative poses to workers, residents, and the environment during implementation.

6. **Implementability** considers the technical and administrative feasibility of implementing the alternative, such as the practicability and difficulty of construction, and the availability of goods and services.

7. **Cost** considers the estimated capital and operation and maintenance costs, as well as net present worth costs. Net present worth is the total cost of the alternative over time in terms of today's dollars.

**MODIFYING CRITERIA**

8. **State acceptance** considers whether the State agrees with U.S. EPA's analyses and recommendations of the studies and evaluations performed.

9. **Community acceptance** is determined from the public comments received as a result of this document.

## IV.B NINE CRITERIA ANALYSIS OF THE SECOND AMENDED REMEDY

**THRESHOLD CRITERIA**

1. Overall protection of human health and the environment. The TIC remedy will protect human health and the environment by immediately preventing unacceptable exposures to soils, sludge and groundwater through containment, and providing for treatment of wastes by phytoremediation offering a more permanent reduction and elimination of risk. This is accomplished through containment and extraction of contaminated groundwater, treatment of extracted groundwater to meet substantive Federal and State requirements, placing a barrier wall and a cover over and around the contaminated soils, and use of phytoremediation to further reduce contaminant concentrations. The remedy will provide for long-term operation and maintenance programs. With the remedy

components and provision and commitments for long term O&M and monitoring required by this ROD Amendment, the TIC remedy is equivalent to the Landfill Remedy because it provides equivalent immediate risk reduction (elimination of the airborne and direct contact pathways), minimization of contaminant mobility, and equivalent groundwater extraction and treatment. The TIC remedy offers a provision for treatment by phytoremediation that the Landfill Remedy does not have. This treatment component can reduce contamination to acceptable levels and provide more permanent long term protection.

2. Compliance with ARARs. The TIC remedy will comply with all substantive requirements of the identified State and Federal ARARs. Part 201 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (formerly known as the Michigan Environmental Response Act) requires that a remedial action achieve categorical cleanup standards, such as residential, commercial, or industrial. Cleanup criteria associated with a future industrial land use will apply to on-site[2] contamination unless appropriate deed restrictions can not be obtained, in which case criteria for future residential land use will apply.

For the TIC remedy, it is expected that State groundwater requirements and Federal MCLs will immediately be met off-site and outside the TIC remedy area because this remedy would immediately eliminate mobility of contaminants through containment, and may ultimately achieve cleanup goals by the treatment provided by phytoremediation. Extracted groundwater will be treated to meet all applicable discharge standards, and will also seek to comply with cleanup goals intended for protection of Big Black Creek. The soils to be contained within the barrier wall will include all soils for which the Risk Assessment in the RI and Part 201 require action.

In the event it is later determined that the permeable O.U. #1 lagoon area cover is not making any significant positive contribution to site remediation, or the redundant groundwater containment and extraction systems fail to provide adequate containment of contaminated site groundwater, or if the implementation of a Contingent Remedial Action (CRA) regarding the lagoon area is determined to be appropriate, RCRA and Part

[2] For purposes of this ROD Amendment, 'on-site' means all property within the former Bofors-Nobel property boundaries except for any property to the South of the northern shore of Big Black Creek. For purposes of this SOW, 'off-site' means any property beyond the former Bofors-Nobel property boundaries to the North, East and West, and beyond the northern shore of Big Black Creek to the South.

111 of NREPA will be considered relevant and appropriate requirements for any upgrade to the cover.

The TIC remedy construction activities will be implemented to meet substantive requirements of all Federal, State, and local regulation dealing with potential releases resulting from excavation, site preparation, or other site work. The TIC remedy is expected to comply with all such ARARs identified for O.U. #1 within the 1990 ROD and 1992 ROD Amendment, but is expected to generate fewer releases than those anticipated for the Landfill Remedy. A more detailed discussion of all ARARs for this site is included in Appendix A to this document.

**PRIMARY BALANCING CRITERIA**

3. Long Term Effectiveness and Permanence. With the remedy components and provision and commitments for long-term O&M and monitoring required by this ROD amendment, the TIC remedy provides immediate risk reduction equivalent to the Landfill Remedy. Direct contact risks associated with residual soils for both remedies, as well as soils and sludge waste within containment structures would be small, as exposure would be eliminated. Long term effectiveness was provided by the Landfill Remedy by preventing exposure to the most highly contaminated site soils and sludges through containment in a secure landfill. With the treatment provided by phytoremediation, the TIC remedy potentially may offer a more permanent elimination of risk by achievement of cleanup goals, affording discontinuation of containment mechanisms.

Risks resulting from contaminants leaching into Site groundwater would be minimized because of the containment provided by the groundwater extraction mechanisms and physical containment. Over time, the levels of this contamination would be reduced for both remedies. The Landfill Remedy relied upon flushing and collecting contamination from material that was not landfilled. With the TIC remedy, the levels in both soil and groundwater may ultimately be reduced by treatment and extraction to concentrations that are no longer unacceptable.

Long term effectiveness of the TIC remedy depends: on maintaining the integrity of the barrier wall and O.U. #1 lagoon area cover; on continuing operation of the existing groundwater treatment plant (or an acceptable equivalent alternative); on the continued O&M of the extraction system at levels adequate to contain groundwater that continue to exceed relevant criteria; and on the effectiveness of the treatment mechanisms provided by phytoremediation. The O&M will ensure that the barrier wall and

any supplemental extraction system continues to contain contaminated groundwater, that discharged groundwater meets applicable criteria, and that the cover continues to provide an effective barrier to unacceptable exposure to soils and sludge. This management is particularly important because, although ongoing treatment, infiltration, and extraction of contaminated groundwater may reduce contaminant concentrations, there is no certainty that those levels will be immediately reduced appreciably. As its goal for groundwater, the TIC remedy will ultimately achieve Part 201 cleanup criteria or Federal maximum contaminant levels (MCLs), whichever are more stringent, throughout the affected groundwater area. Achievement of these criteria insures that groundwater is protected under a reasonable future land use scenario and for discharges to surface water. For those listed contaminants that have Federal MCLs, the Part 201 cleanup criterion is the same as the MCL for that contaminant.

Barrier walls have been constructed at a number of Superfund sites and have been shown to be an effective limitation against migration of contaminants when anchored into a bottom confining layer. This barrier wall component of the TIC remedy would be constructed using a barrier wall that would have depths according to site topography and depth of underlying confining layer to insure retardation of lateral movement of contaminated site groundwater. The combined effect of the barrier wall and groundwater extraction will provide an adequate and reliable long-term containment of contaminated media. It is estimated that the barrier wall for the TIC remedy may range between 70 and 100 feet deep. Although much of the barrier wall construction activity takes place underground and cannot be visually monitored, established quality assurance procedures exist for barrier wall construction and will be implemented during construction of this remedy. Although the adequacy and reliability of the Landfill Remedy was sound, as landfill construction is a proven remediation technology, the requirements defined in this ROD Amendment (including recent modifications) make this amended remedy equivalent.

The adequacy and reliability of the TIC remedy depends on the ability to detect leaks in the barrier wall, and monitor the effectiveness of the barrier wall and any supplemental extraction system. A long-term groundwater monitoring program will be established in the Remedial Design, implemented during construction, and continued after the remedy is operational and functional. If the barrier wall were to fail, escape of contaminants outside the barrier wall and/or unacceptable pressure differentials indicating a breach in the barrier wall

would be detected by sampling and analysis of groundwater monitoring wells. In the event the barrier wall were to develop leaks, additional barrier wall construction can be implemented adjacent to (outside) the first wall in the area where the first wall fails, and/or groundwater extraction can also be utilized to contain any contamination leaks. Compared to the Landfill Remedy, which would have more quickly disclosed failure of the landfill cap and liner system through a leak detection system, barrier wall monitoring requires more time. Consideration of the greater degree of difficulty associated with repair of landfill cells (such as excavation and repair of damaged portions of the cap and/or liner), however, makes the adequacy and reliability of both remedies similar.

Adequacy and reliability is provided by the permeable O.U. #1 lagoon area cover by eliminating airborne contaminant and direct contact threats. The O.U. #1 lagoon area cover would not be designed to minimize infiltration of precipitation, so leaching of contaminants into groundwater may continue. Those contaminants would be extracted and treated, however, through operation of the groundwater extraction system.

Quality assurance procedures for the barrier wall and O.U. #1 lagoon area cover shall be developed and can be implemented during installation to assure the integrity of TIC remedy construction. Continued periodic maintenance of the cover components will be necessary to assure the integrity of the remedy and no unacceptable risk exists to nearby ecosystems. This may be especially important for the portion of the cap (and slurry wall) constructed near O.U. #2 areas where there may be vehicle traffic over TIC remedy components. The Landfill Remedy would have required equivalent periodic inspection and maintenance, such as mowing and vegetation control.

As with the Landfill Remedy, the TIC remedy will be designed such that existing or new groundwater extraction wells, a proven remedial technology, can be used to complement or provide containment of groundwater on both sides of the barrier wall and containment area if needed.

The extraction system will require periodic inspection and maintenance, including inspection for and prevention of biofouling currently occurring within extraction and monitoring wells currently at the site. Extraction wells are regularly cleaned of biofouling deposits using an acid and flocculent polymer solution. Because the current extraction well cleaning procedure may not be the most effective method for the TIC remedy ultimately implemented, a preventive maintenance program

specifically suited for the TIC remedy will be developed during the Remedial Design.

During the Remedial Design, the effectiveness and likelihood for repair and replacement of groundwater collection and discharge system(s) will be investigated and appropriate provision will be made during the Remedial Action for replacement and/or repair as needed.

Long term effectiveness of the groundwater cleanup is directly dependent on continued O&M of the groundwater extraction system and treatment facility. Long term effectiveness is afforded by the GWTP through a combination of several different treatment technologies that (individually) have been shown to be effective for the contaminants involved. In the event any portion of the treatment process fails, the GWTP has been constructed with recirculation and/or storage capabilities to halt the discharge to Big Black Creek until the primary treatment can be repaired or bypassed and an in-place alternative process can be initiated. Treatment operations using identical equipment have been operating for extended amounts of time throughout the country; the plant is therefore anticipated to remain operative for the required length of groundwater treatment time.

For both remedies, the magnitude of residual risk from failure of the groundwater extraction system would be dependent upon the volume of, and levels of contamination in, the untreated contaminated soils remaining within or underneath on-site containment structures and underneath plant areas. It is currently estimated (by the RD groundwater model) that for any failure of the extraction system, a time period of 15 days can elapse before any effect is seen in Big Black Creek. This should allow enough time for repair of any system component. The presence of multiple wells permits interim adjustments to the system to compensate and maintain capture of contaminated groundwater if some wells fail.

For the Landfill Remedy it was expected that soils underneath the proposed on-Site landfill would have continued to contaminate groundwater to an extent that would require constant extraction and treatment of groundwater, until the groundwater cleanup levels were reached. The level of contamination in saturated soils underneath the landfill would have been reduced over time as contamination would be drawn into groundwater which would be in turn extracted and treated. Thus, the impact of soil contamination on groundwater would have been reduced over time. It is anticipated that contaminant reduction may be improved by

the TIC remedy through treatment provided by phytoremediation within contained areas.

Using a computer groundwater flow model, it has been estimated that the groundwater extraction flow rate with implementation of the barrier wall (without installed vegetation) would be very near the natural groundwater flow rate of the aquifer. This would suggest a more desirable situation when compared against the higher flow rates needed by groundwater containment with extraction wells alone. Considering the groundwater uptake provided by the vegetative portions of the TIC remedy, the required extraction rate will likely be further reduced. In the unlikely event the barrier wall and extraction system do not provide containment and contamination escapes, it has been estimated that, without retardation provided by the barrier wall, it would take several days before contaminant particles could reach the Creek. This allows for implementation of CRAs as previously discussed.

Deed and water use restrictions will be implemented to supplement the long term engineering controls which comprise this remedy, so that contact with site related contamination would be further restricted. Deed restrictions can only be implemented by a property owner or a person who controls a property.

Pursuant to Section 300.430(f)(4)(ii) of the NCP, 40 C.F.R. §300.825(f)(4)(ii), U.S. EPA is required to perform a review every five (5) years ("Five-Year Review") after initiation of a Remedial Action if hazardous substances, pollutants, or contaminants remain on-site. Five-Year Reviews determine whether an implemented Remedial Action continues to provide protection of human health and the environment. The TIC remedy includes long term monitoring to provide data on the quality and location of site groundwater and surface water, and data from other required monitoring programs. The required long-term monitoring programs will provide the data necessary for the ongoing review process to assess whether the remedy continues to protect human health and the environment. If, through regular Five-Year Reviews, soil and groundwater cleanup goals are determined to be unachievable, even after implementation of Contingent Remedial Actions, containment will continue and the options available to the Agencies will be reviewed, including an assessment of whether other cost effective treatment options are available. Through the five year review process, determinations will be made as to the effectiveness of the TIC remedy, long term requirements for operation and maintenance of containment systems, including the need to implement CRAs.

4. Reduction of toxicity, mobility, or volume through treatment. With the treatment provided by phytoremediation, this criterion will be satisfied by the TIC remedy for site soil, sludge, and groundwater. As described more fully in previous decision documents, standard treatment processes previously identified to date were not cost effective for this site. The TIC remedy will immediately reduce contaminant mobility by providing containment. It is anticipated that it will ultimately be demonstrated that the TIC remedy provides contaminant reduction and reduction of additional contaminant loadings to groundwater through phytoremediation within contained areas, groundwater extraction and treatment, and attenuation and biodegradation. As with the Landfill Remedy, this criterion will be satisfied for the groundwater, as reduction of toxicity and contaminant volume would occur through use of a groundwater treatment system. Other components of the Landfill Remedy, however, did not satisfy this criterion.

5. Short term effectiveness. During construction, short-term risks posed to the community will consist of: airborne contaminants resulting from earth moving work (necessary grading and excavation) and slurry wall construction, contaminants leaving the site through storm water run-off, and risks to on-site personnel implementing the remedy. Standard engineering, construction, and personal safety measures to minimize these risks will be required as part of the construction design. The Remedial Design for this remedy will require procedures to be followed for dust control, erosion control, and personal safety.

Installation of a real time air monitoring system will be a construction requirement and will be installed around the perimeter of the site. This system will provide updates at regular intervals throughout construction activity and will notify on-site personnel when site emissions reach or exceed regulatory limits. If during construction activity, site dust and/or emissions reach unacceptable levels, the nature, locations, and amount of site activity will be reduced, controlled, or adjusted accordingly. If discharges continue after such changes are implemented, physical means such as mist generation or application of foam cover (or other material) directly at the point of excavation may be utilized. At the end of each daily construction period, excavation and stockpile areas will be covered appropriately to prevent releases during off-hours. A site Health and Safety Plan will be developed to establish procedures to be followed in specific situations, such as site emergencies or potential off-site discharges.

Consideration of short-term effectiveness must also include any potential ecosystem effects that implementation of a remedy will have. Specifically, the construction contractor must avoid disrupting any wetland area, or, if an area is disrupted, coordinate with the State and the USACE to appropriately restore and/or replace and/or mitigate the affected area.

The proposed time to implement the TIC remedy is approximately 8 years, including 1 year to complete further site study and Remedial Design activity, 2 years to install vegetative components and construct the barrier wall and cover, and 5 years for maturation and start-up of the entire remedy. With the use of all preventative and mitigative measures, construction of this alternative over the proposed time period will not pose a greater risk to the community than the risk presented by current conditions at the site. It is anticipated that, when compared against the Landfill Remedy, the TIC remedy will have greater short-term effectiveness because of the reduced amount of earth moving activity.

6. Implementability. Implementation of the TIC remedy will occur in phases. Initially, lagoon areas will be cleaned of debris and graded, requiring standard earth moving and disposal procedures. As surface cleanup and grading occurs, sampling and analysis of lagoon areas will occur, concurrent with design of the O.U. #1 lagoon area cover and barrier wall.

Following surface cleanup and grading, installation of vegetation will occur, followed by construction of the O.U. #1 lagoon area cover and barrier wall. The durable nature of the vegetative species proposed for the TIC remedy suggests no significant implementability problems with planting. Treatment provided by phytoremediation is an innovation whose implementability is undefined, but the redundancy provided by the lagoon area cover and containment systems permits its use. Cap and barrier wall activities utilize proven technology and procedures, and the existing operational groundwater extraction and treatment system will continue to run throughout these activities, until the TIC remedy has been shown to be adequately operating. Contingent Remedial Actions such as the upgrade of the O.U. #1 lagoon area cover installation of new extraction wells, and maintenance of vegetation are not anticipated to present implementability problems.

Barrier wall construction has occurred at many Superfund sites, and standard engineering and construction methods would be implemented. Site topography and loose soil conditions could make barrier wall construction somewhat difficult at this site.

Loose soil conditions may adversely affect slurry wall construction due to the likely migration of slurry mix into surrounding soils. Soils comprised of an inordinate quantity of fines such as those found at Bofors tend to pervade soil-bentonite-water mixes and jeopardize the non-permeability of slurry walls. In the event use of slurry proves difficult, alternative options such as sheet piling may be used, alone or in concert with slurry walls.

Construction quality assurance ("CQA") may be difficult, as there are no direct means (such as compaction tests) to test effectiveness of slurry mix at depth during installation. CQA for slurry walls typically consists of field and lab viscosity tests of slurry mix before placement, and core samples of the wall after installation. In the event slurry mix does not meet specifications after placement, a technique such as in-situ mixing and placement of additional slurry would have to be performed.

Although implementability of the Landfill Remedy was good because of the existence and application of proven techniques, services, and materials for landfill construction, the remedy requirements defined in this ROD Amendment (including recent modifications) and the associated legal agreement have improved the implementability of the TIC remedy. For the Landfill Remedy, construction difficulties would have been spatial, in that maneuvering of earth moving equipment for concurrent liner construction and waste placement may have been be somewhat constricted. It is anticipated that these difficulties will be reduced for the TIC remedy because of the lesser amount of earth moving activity associated with the barrier wall and O.U. #1 lagoon area cover.

Monitoring the effectiveness of the remedy would consist of long term groundwater monitoring and studying the quality of Big Black Creek for adverse effects related to the site. Because wastes will remain in contact with groundwater, the TIC remedy does not contemplate that groundwater within the slurry wall boundary will be cleaned to protective levels in the short term. However, through the treatment provided by phytoremediation, it is anticipated that over the long term, contaminants within the barrier wall boundary may be reduced. The effectiveness of the remedy therefore depends on continuing O&M of the groundwater extraction system and GWTP until it is proven that cleanup goals have been achieved and/or containment of wastes is no longer necessary. The Landfill Remedy would likely have required a similar degree of long term monitoring.

With appropriate maintenance measures, it is expected that the groundwater collection and extraction system installed for the TIC remedy will be capable of performing continuous extraction for extended periods of time. The groundwater extraction system may require further adjustments depending on the interim actions in the plant area and the final O.U. #2 remedy ultimately established by U.S. EPA. Proven techniques, services, and materials for groundwater extraction well systems exist. Implementation of the Landfill Remedy would have resulted in similar improvements to the existing system by installing fewer but more efficient new extraction wells. With appropriate maintenance measures, extraction wells installed for either remedy are capable of performing continuous extraction over their expected life time, resulting in a significant reduction of contaminant concentrations in groundwater. If any those extraction well pumps should need replacement before cleanup standards are achieved, replacement equipment can be readily obtained and installed. In addition, well maintenance will continue to include cleaning out of material caused by biological fouling as needed.

Implementability of the groundwater treatment plant is demonstrated by the fact that the plant has been successfully constructed and is now operating in compliance with State surface water discharge limits since 1994.

Consideration of implementability of a remedy must take into account the difficulty of undertaking any further Remedial Actions. For the Landfill Remedy, an additional Remedial Action could have been conducted, but might have been difficult in the event of excavation of the landfill liner and cap. It was not anticipated that soil and sludge contained in the landfill would have been disturbed for some time (the specifications required a minimum 80 years containment), but in the event some new remediation technology had become available, or an existing technology was developed to be technically and fiscally practicable to the Site, waste contained in the landfill cells may have been removed and managed in a more definitive manner. With containment of wastes in place, the TIC remedy affords easier access for further Remedial Action.

7. Cost. TIC remedy cost depends on whether Contingent Remedial Actions are implemented. Tables 5 through 7 provide a detailed break down of capital and O&M costs for all implementation phases of the TIC remedy, and do not include U.S. EPA expenditures to date.

Costs (including cost estimate contingencies) and implementation time frames are summarized as follows:

| | |
|---|---|
| TIC remedy Remedial Design: | $ 5,450,000 |
| TIC remedy Minimum Construction Requirements[3]: | $ 10,189,990 |
| Additional Construction capital for CRAs: | $ 4,594,540 |
| Total (Maximum Construction Capital Cost): | $ 14,784,530 |
| Minimum Project Cost (RD plus Minimum Construction): | $ 15,639,990 |
| Annual O&M and Monitoring[4] - Yrs 1 to 3: | $ 830,000 |
| Annual O&M and Monitoring[5] - Yrs 3 to 8: | $ 770,000 |
| Annual O&M and Monitoring[5] - Yrs 8 to 33: | $ 570,000 |
| Annual O&M and Monitoring[5] - Yrs 33 to 103: | $ 353,000 |
| Present Worth of Annual O&M & Monitoring (including contingency): | $ 14,932,160 |
| Minimum Net Present Worth[5] of Project: | $ 25,123,150 |
| Maximum Net Present Worth[6] of Project: | $ 29,716,690 |

Estimated Implementation Time: It is anticipated that 8 years will be required, including 1 year for RD, 2 years for installation of vegetative components and construction of the Barrier Wall, and 5 years for maturation and start-up of the entire TIC remedy. Literature suggests that for the nature and extent of contamination present at the site, treatment mechanisms provided through phytoremediation may reduce site contamination to acceptable levels within an approximate time of 30 to 70 years, with the most appreciable reduction occurring in the initial 20 years.

[3] "Minimum Construction Requirements" is the construction capital cost for the basic TIC Remedy. Includes 25% cost estimate contingency (see Table 5).

[4] O&M and monitoring costs are anticipated to decrease as the project time period increases. The "time weighted" annual monitoring cost is $ 56,760 and the "time weighted" annual O&M cost is $ 383,590 (see Table 7).

[5] Net present worth of project is the sum of capital costs plus total present worth of annual costs (not including RD or U.S. EPA cost to date).

**MODIFYING CRITERIA**

8. State Acceptance. The State's approval of this remedy was provided after affirmation of the commitment to:

a. the installation and implementation of an approved monitoring system downgradient of the barrier wall; and

b. the installation of extraction wells along Big Black Creek to prevent the discharge of contaminated groundwater to the Creek at concentrations in excess of State standards, prior to or in conjunction with barrier wall construction,

as defined in Section III.E of this ROD Amendment and in the associated legal agreement(s).

9. Community Acceptance. The Proposed Plan for this ROD Amendment, provided to collect community input, was issued on June 15, 1998, and a notice placed in the Muskegon Chronicle on June 17, 1998. Comments received from the community appear in favor of this remedy. All comments received during the comment period of June 15, 1998 to July 17, 1998 were reviewed and responded to in a Responsiveness Summary, which is included as Appendix B to this ROD Amendment and will be made part of the public record for the site.

## V. STATUTORY DETERMINATIONS

The TIC remedy described herein complies with the requirements of CERCLA §121 by controlling site risks posed by groundwater, air, or direct contact with hazardous materials through the containment of site soils. This action will not cause unacceptable short-term risk or cross-media impacts. This TIC remedy complies with all State and Federal ARARs. There are no chemical, action or location-specific ARARs identified for this action that were not identified and discussed in the remedy re-evaluation document dated July 16, 1996. The TIC remedy is cost-effective and reduces costs associated with construction sequencing, material handling, temporary storage of contaminated soils, and O&M for groundwater extraction and treatment.

The TIC remedy provides the best balance of trade-offs with respect to U.S. EPA's remedy evaluation criteria. Other considerations include the evaluation of reasonably anticipated future land use for the site as industrial, the revised State of Michigan statutes applicable to site cleanup, the associated cleanup criteria, and short term risk and long term requirements for construction of the remedy alternatives.

With the treatment provided by this remedy, this action satisfies the preference for treatment as a principal element of the remedy. Given the time requirement for maturation of the vegetative portions of the TIC remedy, however, treatment effectiveness can not be immediately measured. Reduction of the toxicity, mobility, or volume of site wastes will immediately occur through the baseline remedy provision for containment of site waste in place, and the significant extraction and treatment of contaminated groundwater.

Goals of this second amendment to the ROD for the O.U. #1 remedy at the Bofors-Nobel Site are containment of sludge, soils, and groundwater as the base component to immediately address the threat from contamination in the lagoon area and in site wide groundwater, and reduction of soil and groundwater contamination levels through treatment provided by phytoremediation, groundwater extraction and treatment, and attenuation and bio-degradation. The Remedial Action Objectives (RAOs) for this remedy to ensure containment are as follows:

1. Containment of lagoon sludge and soils to prevent on-site[6] exposure to hazardous substances at concentrations that pose an unacceptable risk to human receptors under industrial land use scenarios via the following routes of exposure: (a) direct contact; (b) inhalation from volatization to indoor air; (c) inhalation from volatization to ambient air; (d) drinking water use of aquifer; (e) groundwater contact; and (f) surface water contact. Containment of lagoon sludge and soils to prevent on-site exposure to hazardous substances at concentrations that pose an unacceptable risk to environmental receptors via the following routes of exposure and migration pathways: (a) contact with contaminants present in surface soils, plants, water or air on-site; (b) groundwater impacts on surface water; and (c) soil runoff impacts on surface water.

2. Containment of lagoon sludge and soils to prevent off-site migration of contaminants to air, soil or groundwater at concentrations that would pose an unacceptable risk to human and/or environmental receptors; and

3. Containment of groundwater to prevent migration of contaminants at concentrations that would pose an

[6] For purposes of this ROD Amendment, 'on-site' means all property within the former Bofors-Nobel property boundaries except for any property to the South of the northern shore of Big Black Creek. For purposes of this ROD Amendment, 'off-site' means any property beyond the former Bofors-Nobel property boundaries to the North, East and West, and beyond the northern shore of Big Black Creek to the South.

unacceptable risk to human and/or environmental receptors off-site including Big Black Creek and to the on-site wetlands between Big Black Creek and the barrier wall.

In order to ensure these objectives are met and maintained, the remedy includes:

- measurement of the effectiveness of containment systems including measurement of the reduction in contaminant concentrations; and

- operation and maintenance of containment systems until such time as it is determined that continued operation of containment is unnecessary.

The remote location and current zoning of the site as industrial supports the assertion that the reasonably anticipated future land use for the site is industrial in nature. Part 201 of NREPA requires that zoning of a property where a remedy is implemented be consistent with the categorical criteria applied at the site. The current zoning of the former Bofors-Nobel Site is industrial, as are the cleanup criteria being applied on site (conditional upon appropriate land use and deed restrictions). U.S. EPA foresees that appropriate institutional controls, such as deed restrictions and land use restrictions, combined with standard security measures will be adequate to prevent or limit the exposure potential for nearby residents and will guarantee that components of the remedy will remain intact.

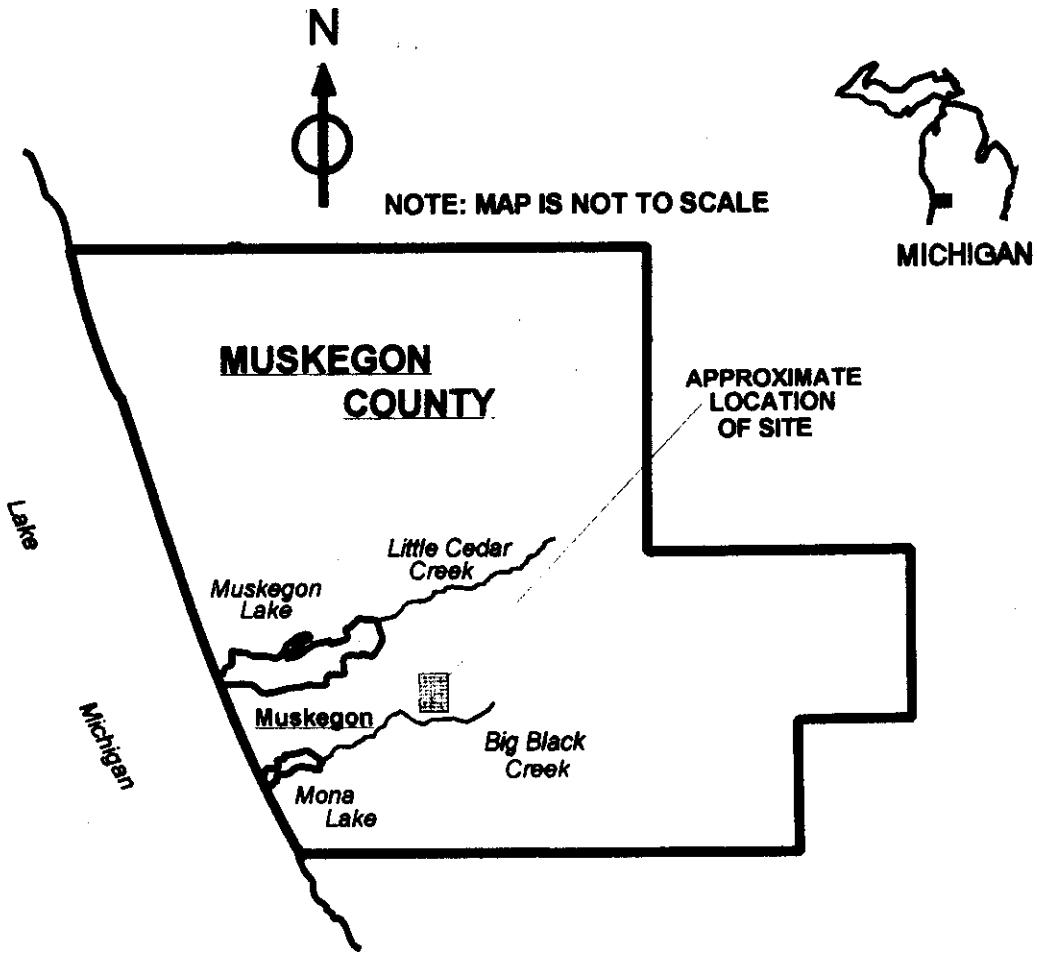



**FIGURE 1 - COUNTY LOCATION OF BOFORS-NOBEL SITE**

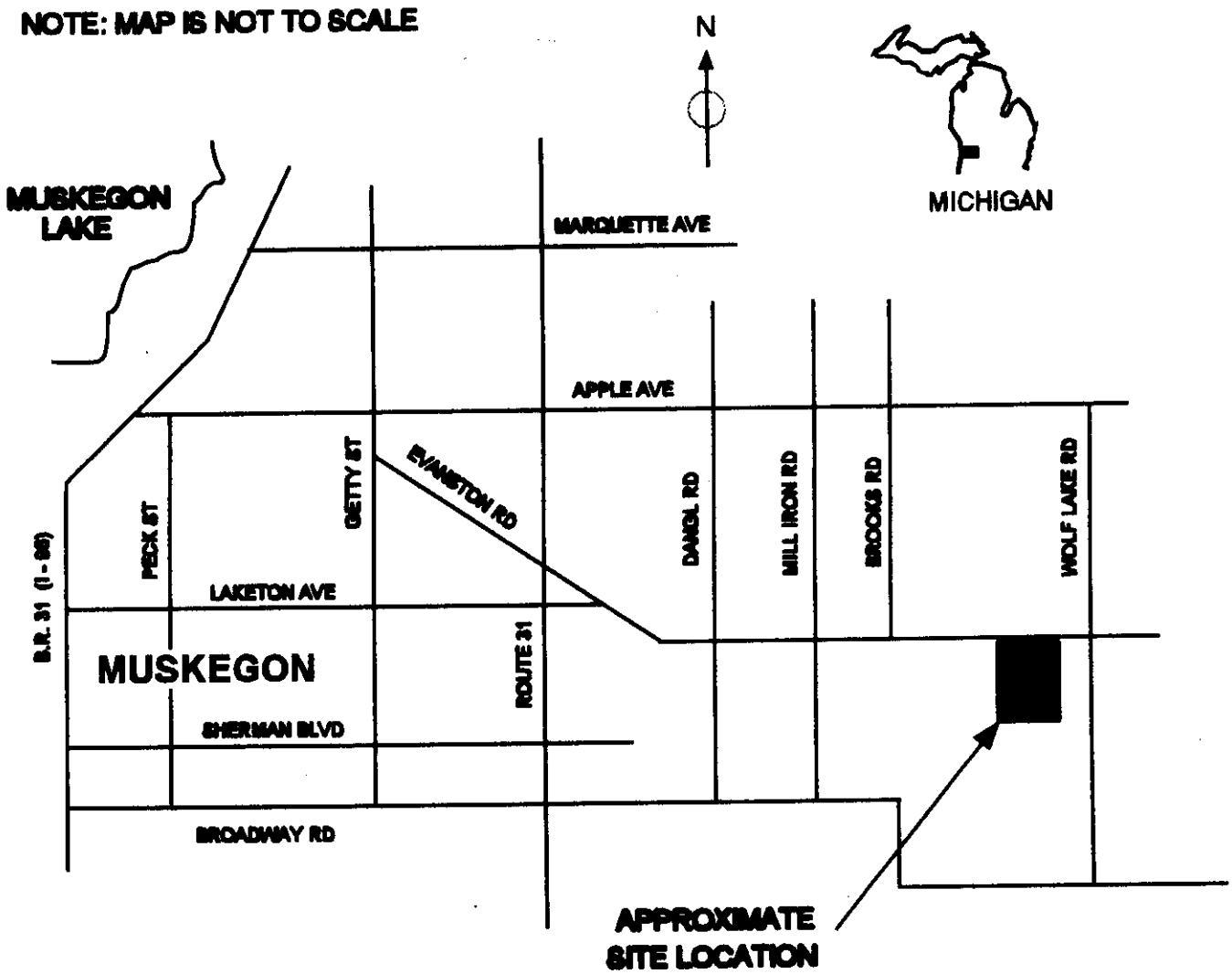



**FIGURE 2 - SITE LOCATION MAP**
BOFORS - NOBEL SUPERFUND SITE;
EGELSTON TOWNSHIP, MICHIGAN

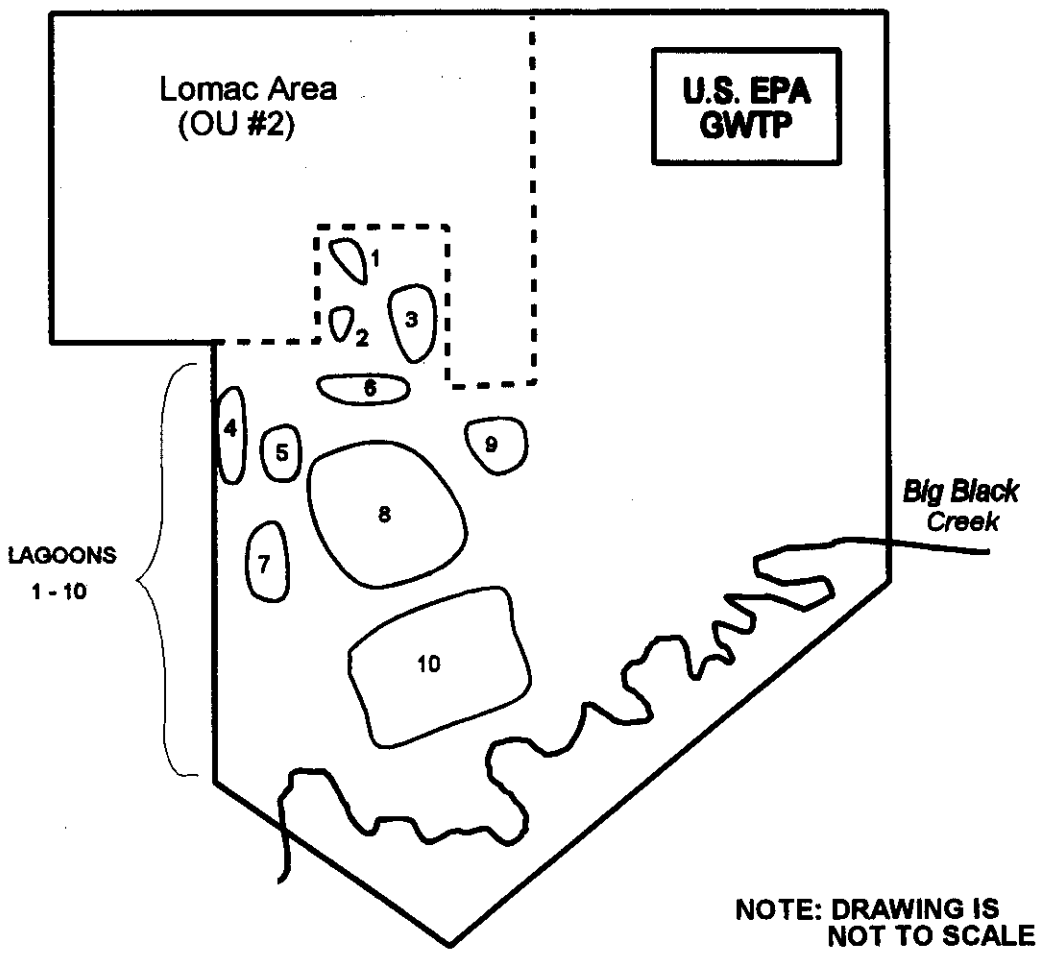



**FIGURE 3 - BOFORS-NOBEL SITE LAYOUT**

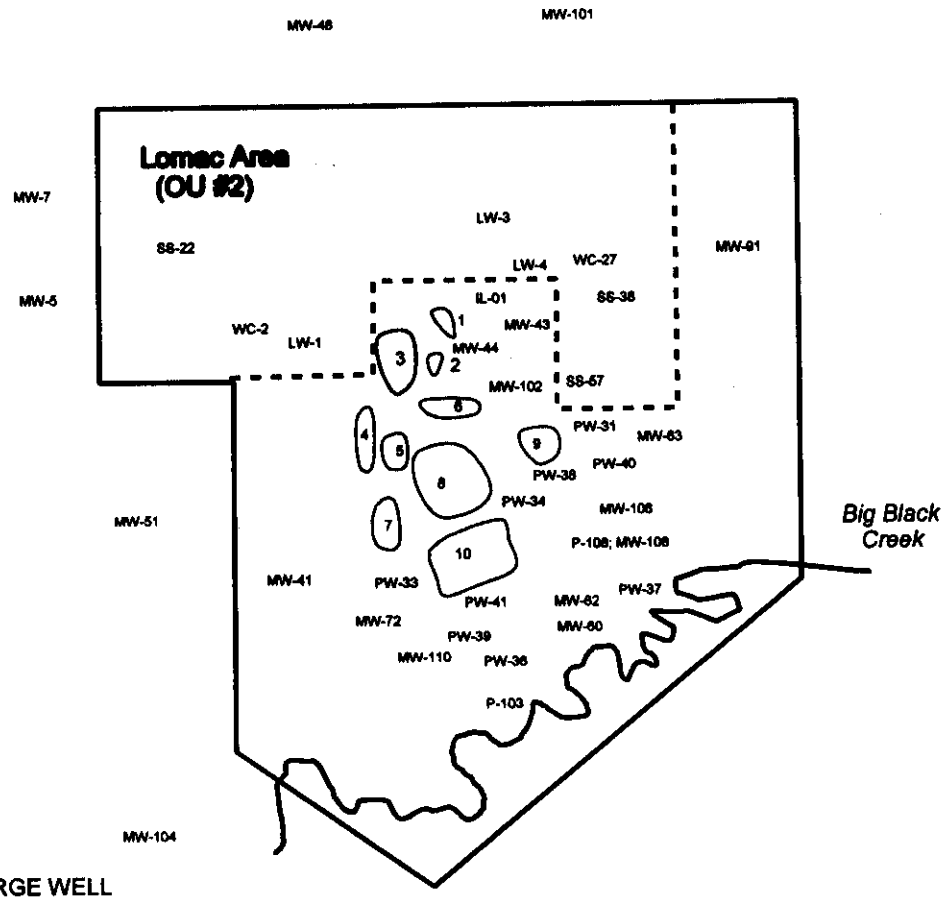
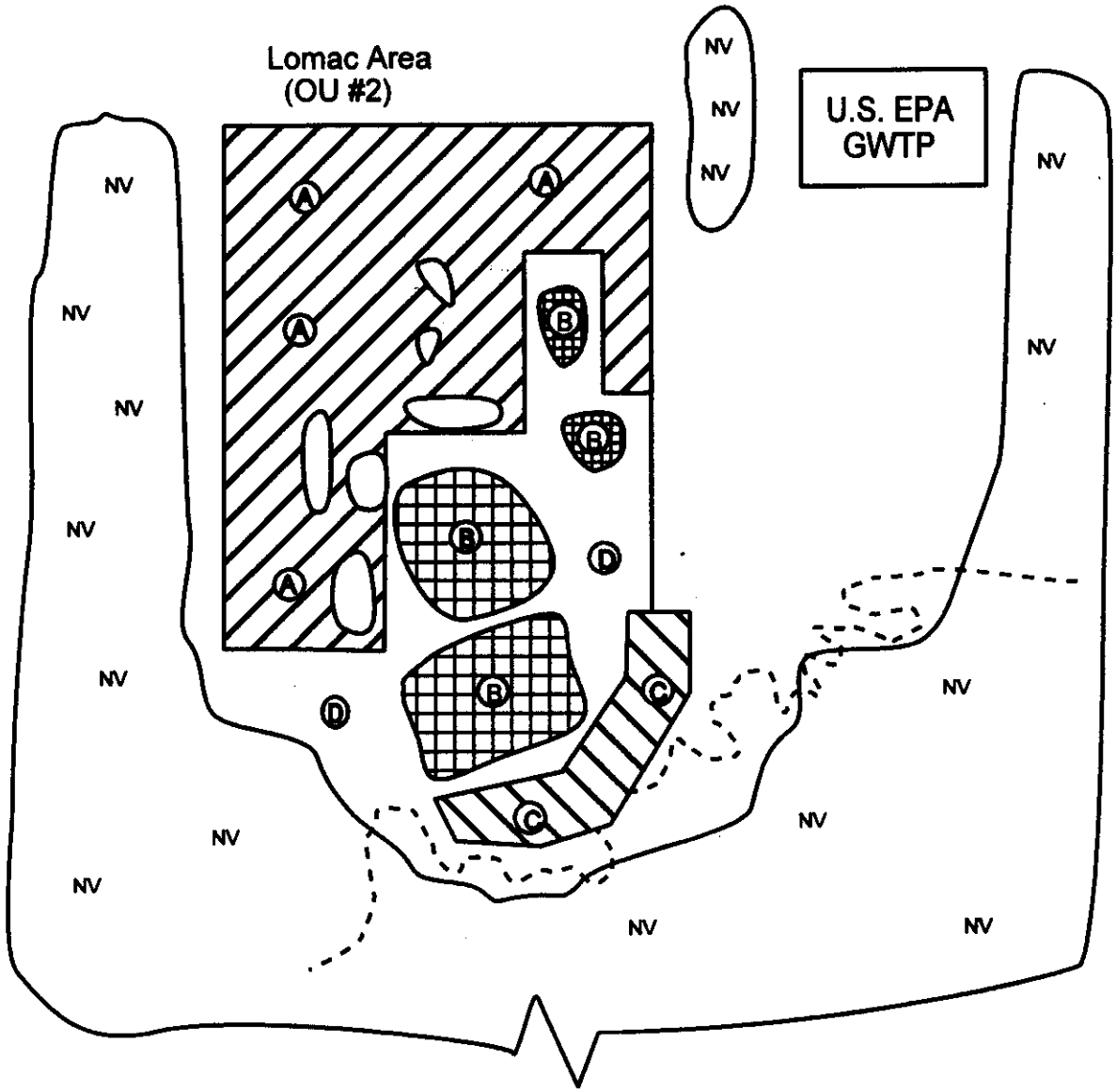



**FIGURE 3A - BOFORS-NOBEL SITE LAYOUT AND APPROXIMATE SAMPLING LOCATIONS**




ZONE A - HIGH DENSITY HYBRID POPLAR
ZONE B - HIGH DENSITY EASTERN RED CEDAR
ZONE C - HYBRID POPLAR
ZONE D - GRASS AND RED CEDAR
NV - NATIVE VEGETATION

**FIGURE 4 - PRELIMINARY LAYOUT OF INSTALLED VEGETATION**

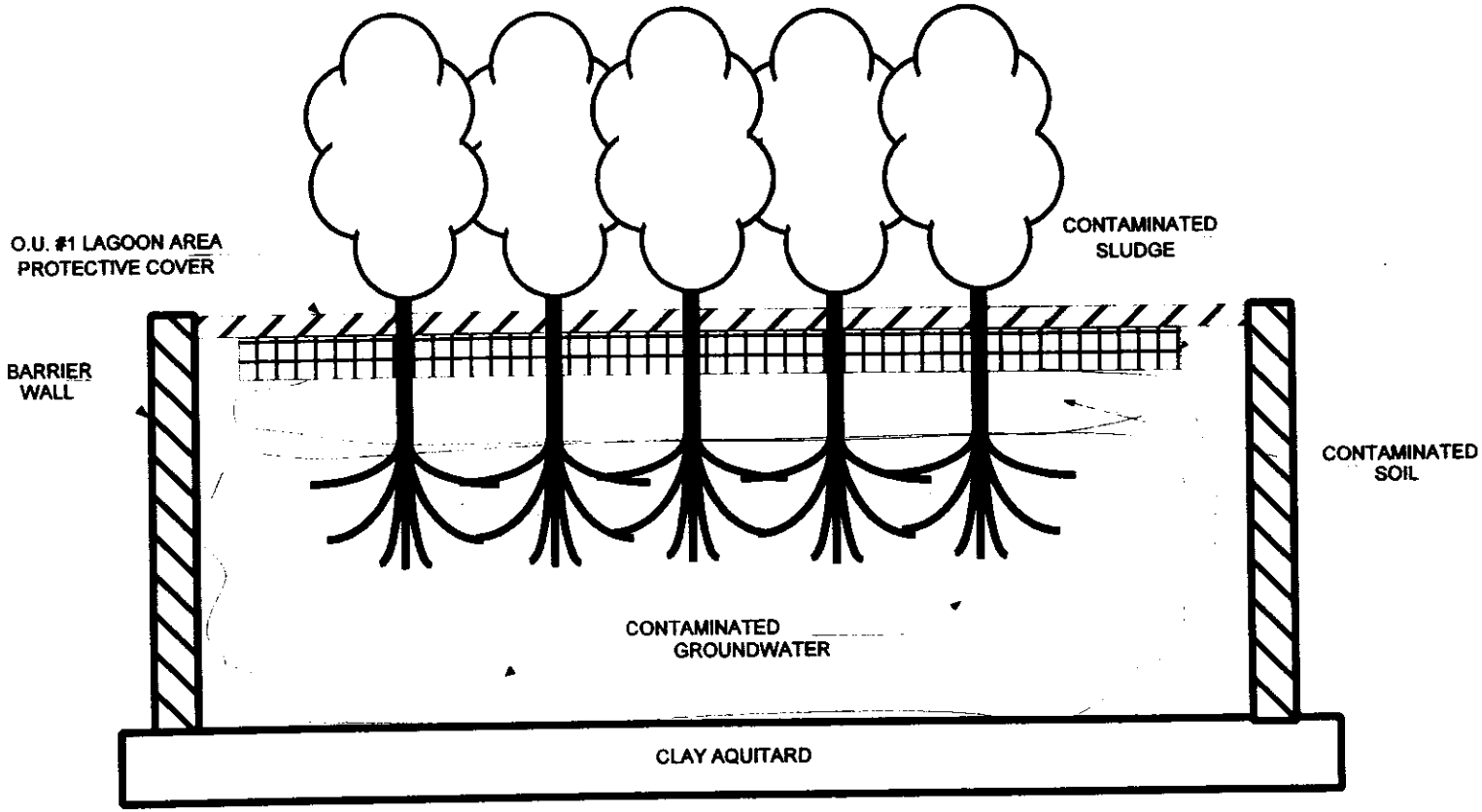



**FIGURE 5 - PRELIMINARY CROSS-SECTION OF TIC REMEDY**

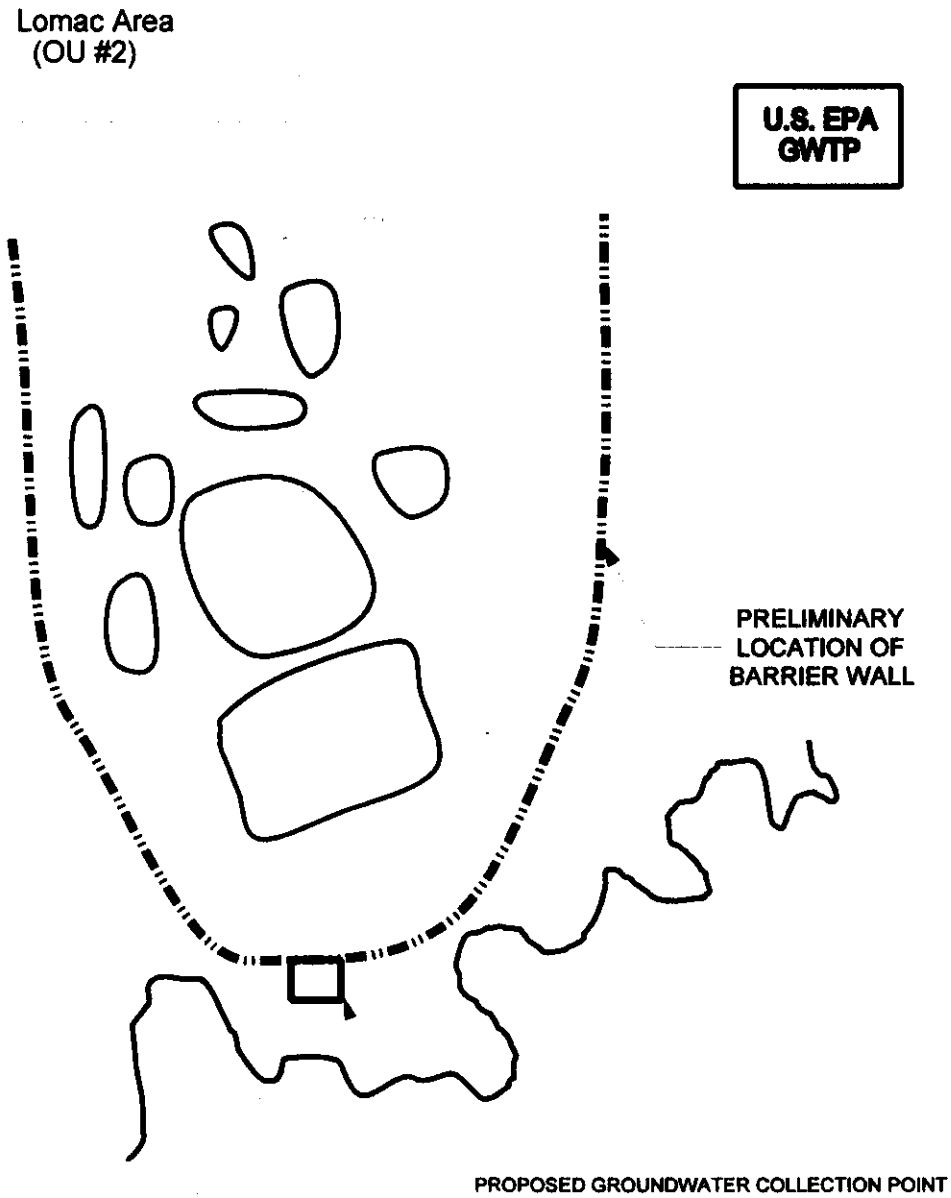



**FIGURE 6 - PRELIMINARY LOCATION OF BARRIER WALL**

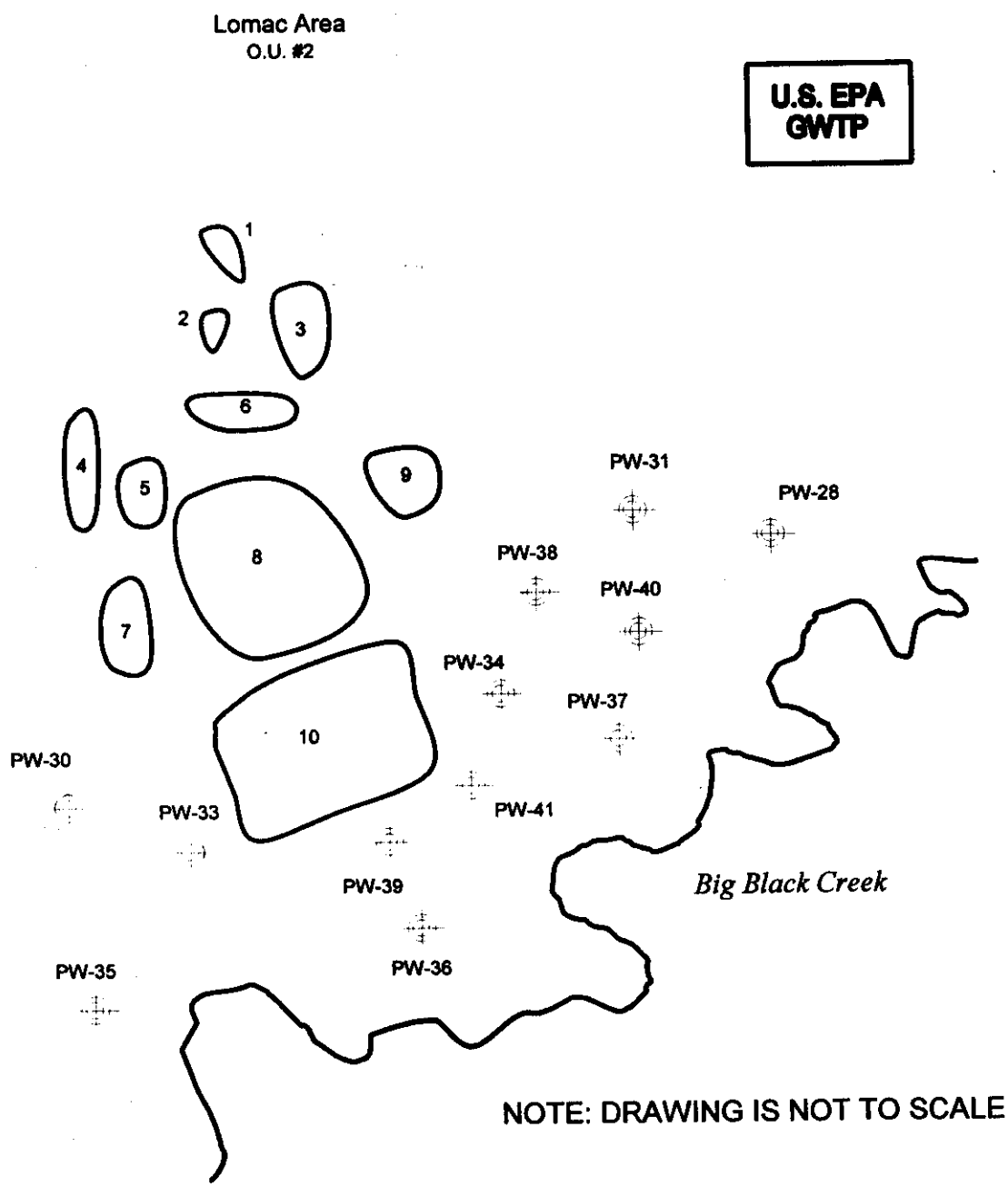



**FIGURE 7 - LOCATION OF EXISTING GROUNDWATER EXTRACTION WELLS**

## TABLE 1 - CONTAMINANTS IN SLUDGE AND SOIL AND SOIL CLEANUP CRITERIA (PERFORMANCE STANDARDS) - O.U. #1 LAGOON AREA - BOFORS-NOBEL SITE

| CONTAMINANT | PART 201 RPGW [2] (ppb) | PART 201 IPGW [2] (ppb) | PART 201 GSIPGW [2] (ppb) | PART 201 IND. DCV [2] (ppb) | LAGOON NUMBER (Approximate Location); Contaminant Concentration in ppb | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BACKGD [3] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Acetone | 15000 | 42000 | 34000 | 7.40e+07 | ND [4] | 70 | | | | | | | | 91 | 11 |
| Alkyl benzene isomers [12] | N/L [5] | | | N/L [5] | ND [4] | | | 148000 J | | | 123000 J | | 147000 | 148000000 J | 4400 |
| Aniline (cc) | 3000 | 12000 | IP [9] | 4.50e+06 C [14] | ND [4] | 860 | | 9200 | | | | | 1700 | 3900000 | 3400 |
| Azobenzene (cc) | 1400 | 5900 | N/A [5] | 1.40e+06 | ND [4] | 93 J | | 12000000 | | 170000 | 680000 | 22000 J | 33000 J | 8200000 | 230000 |
| Azoxybenzene | N/L [5] | | | N/L [5] | ND [4] | | | 690000 J | | | | | | 36000 | 85000 |
| Benzene (cc) | 100 | 100 | 4000 X [13] | 400,000 C [14] | ND [4] | | | 980000 | | 23 | | | 2800 | 120000 | 8 J |
| Benzidine (cc) | 1000 M [11] | 1000 M [11] | ID [7] | 1,000 M [11] | ND [4] | | | 3400000 | | 2100 J | 70000 J | | 13000 | 1300000 | 13000 |
| 2-Butanone (MEK) | 260000 | 760000 | 44000 | 2.70e+07 C [14] | ND [4] | | | | | | | | | 25 J | |
| 2-Chloroaniline | N/L [5] | | | N/L [5] | ND [4] | 260000 | | 270000 | | 540 | 22000 J; 21000 | 240 | 12000 J | 2300000 | 24000 J |
| (3-Chlorophenyl) (4-Chlorophenyl) Methanone | N/L [5] | | | N/L [5] | ND [4] | 300000 J | | 6100000 J | | 330000 J | 1,300,000 | 520000 J | 34000 J | 6200000 | 190000 J |
| 3,3'-Dichlorobenzidine (and isomers) (cc) | 2000 M [11] | 2000 M [11] | 2000 M [11], X [13] | 55000 | ND [4] | 65000 J | | 2700000 | | 930000; 950000 J | 390000; 1000000 J | 260000; 100000 J | 1500000; 1700000 J | 11,000,000 | 2900000; 3500000 J |
| Ethylbenzene | 1500 | 1500 | 360 | 140,000 C [14] | ND [4] | 51 | | | | | 9,200 | 1 | | | |
| Methylene Chloride (cc) | 100 | 100 | 19000 X [13] | 2.30e+06 C [14] | ND [4] | | | | | 4 J *** | 2200 J ** | 18 *** | 1200 J | | |
| Sulfur - NP [10] | N/L [5] | | | N/L [5] | ND [4] | 5100 J | | | | | | 8300 J | | 1500 | |
| 1,1' - Sulfonyl - bis (2-Methyl) Benzene | N/L [5] | | | N/L [5] | ND [4] | | | | | | | | | | 82000 J |

## TABLE 1 - CONTAMINANTS IN SLUDGE AND SOIL AND SOIL CLEANUP CRITERIA (PERFORMANCE STANDARDS) - O.U. #1 LAGOON AREA - BOFORS-NOBEL SITE

| CONTAMINANT | PART 201 RPGW [2] (ppb) | PART 201 IPGW [2] (ppb) | PART 201 GSIPGW [2] (ppb) | PART 201 IND. DCV [2] (ppb) | LAGOON NUMBER (Approximate Location); Contaminant Concentration in ppb | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BACKGD [3] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Tetrachloroethylene | 100 | 100 | 900 X [13] | 88000 C [14] | ND [4] | | | | | | | 82 | 680 | | |
| Toluene | 16000 | 16000 | 2800 | 250000 C [14] | ND [4] | 8,900 | | 1,100,000 | | 17 | 130,000 | | 80,000 | 1600000 | 210 |
| 1,2,4 - Trichlorobenzene | 4200 | 4200 | 1800 | 1.1e+06 C [14] | ND [4] | | | 350 | | 150 | 150 | | 7,100 | 250000 | |
| Unknowns **** [10] | | | | NP [10] | 26 J | | 1400 J | | | 5700 J | 503000 J | 19000 J | | | 14400 J |
| Xylenes (total) | 5600 | 5600 | 700 | 150,000 C [14] | ND [4] | 120 | | | | 14 | 58,000 | | | | |
| | | | | | | | | | | | | | | | |
| Aluminum | 1000 | 1000 | N/A [5] | 3.00e+08 | 3770000 | 250000 | 1110000 | 1740000 | 781000 | 7920000 | 4070000 | 1900000 | 6220000 | 1930000 | 3830000 |
| Antimony [10] | 4300 | 4300 | ID [7] | 1.60e+06 | ND [4] | 25200 | | | | | | | | | |
| Arsenic | 23000 | 23000 | 70000 X [13] | 100000 | ND [4] | 43800 E | 630 J | 6100 | 600 J | 3600 | 5100 | 780 J | 3700 J | 2700 J | 3300 J |
| Barium | 1.30e+06 | 1.30e+06 | 130000 | 3.20e+08 | 12600 J | 9800 J | 5700 J | 40300 J | 3400 J | 48000 J | 43400 J | 18300 J | 85000 | 18300 J | 44700 J |
| Beryllium | 51000 | 51000 | G [13] | 2.30e+07 | ND [4] | | | 670 J | | 540 J | 2100 | 320 | | | 2400 |
| Cadmium | 6000 | 6000 | G,X [13] | 2.30e+06 | ND [4] | 424000 | | 21900 | | | | | | 15100 | |
| Calcium - NO [10] | | | G,X [13] | 4.5 e+06 | 109000 J | 83000 J | 242000 J | 64600000 | 676000J | 194000000 | 265000000 | 7350000 | 253000000 | 25900000 | 271000000 |
| Chromium | 30000 | 30000 | 3300 | 2.20e+07 | 2200 | 916000 | 2400 | 79500 | | 22100 | 12100 | 17000 | 68000 | 45700 | 21200 |
| Cobalt | 1000 | 2000 | 2000 | 2.30e+07 | 2200 J | 36700 | | | | 3500 J | 7700 J | | | | 3400 J |
| Copper | 1.60e+08 | 1.60e+08 | G [13] | 1.70e+08 | ND [4] | 1640000 | 41200 | 226000 | | 19100 | 14300 | 6400 | 2800 | 36700 | 27100 |
| Iron - NO [10] | 6000 | 6000 | N/A [5] | ID [7] | 2650000 | 5460000 | 2660000 | 11000000 | 1420000 | 3780000 | 2550000 | 3870000 | 2920000 | 13000000 | 1430000 |
| Lead | 1000 M [11] | 1000 M [11] | G,X [13] M [11] | 900,000 L [8] | 3200 | 6040000 E | 6200 | 887000 | 700 J | 34700 | 20800 | 37400 | 29700 R | 362000 | 12500 E |

**TABLE 1 - CONTAMINANTS IN SLUDGE AND SOIL AND SOIL CLEANUP CRITERIA (PERFORMANCE STANDARDS) - O.U. #1 LAGOON AREA - BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 RPGW [2] (ppb) | PART 201 IPGW [2] (ppb) | PART 201 GSIPGW [2] (ppb) | PART 201 IND. DCV [2] (ppb) | LAGOON NUMBER (Approximate Location); Contaminant Concentration in ppb | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BACKGD [3] | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Magnesium - NO [10] | 8.40e+06 | 2.40e+07 | N/A [5] | 1.0e+09 D [6] | 342000 J | 95000 J | 368000 J | 1840000 | 459000J | 2870000 | 2350000 | 721000 J | 3400000 | 3050000 | 2470000 |
| Manganese | 2000 M [11] | 2000 M [11] | G,X [13] | 2.10e+08 | 17300 | 2680000 | 41200 | 85200 | 23900 | 52000 | 46400 | 58600 | 71600 | 164000 | 32800 E |
| Mercury | 1700 | 1700 | 170 | 1.40e+06 | ND [4] | 150 E | 100 | 710 | | | | | | 330 | |
| Nickel | 100000 | 100000 | G [13] | 3.40e+08 | ND [4] | 460000 | 2100 J | 21000 | | 17500 | 10300 J | 9300 | 3600 J | 15100 | 4800 J |
| Potassium - NO [10] | | | | NO [10] | 86400 | | 71800 J | 189000 J | 106000 J | 412000 J | 245000 J | 79300 J | 394000 J R | 104000 J | 132000 J |
| Selenium | 4000 | 4000 | 400 | 2.30e+07 | ND [4] | | 680 J | 3300 | | | | | | | 2400 J |
| Silver | 4500 | 13000 | 500 M [11] | 2.10e+07 | ND [4] | 15600 | | | | 4600 | | | | 1800 J | 1200 |
| Sodium [10] | 3.20e+06 | 9.00e+06 | N/A [5] | 1.0e+09 D [6] | ND [4] | | 26100 J | 5920000 | 44000 J | 191000 J | 169000 J | 49900 J | 366000 J | 3500000 | 318000 J |
| Thallium | 2300 | 2300 | 4200 X [13] | 300000 | ND [4] | | | | | | | | | | |
| Vanadium | 1.00e+06 | 2.90e+06 | 240 | 3.90e+07 | 4800 | 28,600 | 3000 J | 4200 J | 940 J | 17700 | 10800 J | 4600 J | 9300 J | 5400 J | 6200 J |
| Zinc | 2.40e+06 | 5.00e+06 | G [13] | 1.0e+09 D [6] | 1240000 | 59,400 | 15,900 | 91,200,000 | 18,500 | 1,240,000 | 1,280,000 | 8,370,000 | 2,510,000 | 61,800,000 | 1,270,000 |

**FOOTNOTES AND LEGEND FOR TABLE 1**

(cc) Baseline risk assessment identified this contaminant as presenting a major Site risk. Baseline risk assessment did not identify any inorganic contaminants as contaminants of concern.

1 Data taken from Record of Decision and February 1990 Remedial Investigation (RI) Report. Data represents maximum concentrations found in soils or sludge samples taken in lagoon area at an average depth of 10 feet deep. (Soil samples - 2 to 6 ft.; Sludge 10 to 12 ft.). No PCBS or pesticides (other than those shown) were detected. Blank spaces in Table 1 signify that compound was not detected in laboratory analysis. See Table 3 for current site conditions. Values shown in format "1.0e+09" are scientific notation (i.e.,1.0e+09 = 1,000,000,000; 1.0e+06=1,000,000; 1.0e-03=0.001; 1.0 e-06=0.000001).

2 **IPGW** - Industrial Soil Cleanup Criteria Protective of Groundwater as of June 1999. This is the contaminant concentration in soil which, if not exceeded, insures that groundwater is protective for human consumption under a future industrial land use scenario. **RPGW** - Residential Soil Cleanup Criteria Protective of Groundwater as of June 1999. This is the contaminant concentration in soil which, if not exceeded, insures that groundwater is protective for human consumption under a future residential land use scenario. **GSIPGW** - Soil Cleanup Criteria Protective of GSI Criteria for Groundwater as of June 1999. This is the contaminant concentration in soil which, if not exceeded, insures that groundwater is protective for Big Black Creek. **DCV** - Direct Contact Value - Part 201 Industrial Direct Contact Value as of June 1999. This is the contaminant concentration in soil which, if exceeded, presents an unacceptable human risk by contact with the soil within a typical industrial scenario. Any exposure to lagoon area soil would be to an individual working on the Site within a controlled work environment. The DCV criterion is the basis for the O.U. #1 lagoon area cover component of the TIC remedy.

3 BACKGRD - Background concentration taken from sample in relatively "clean" site area.

4 ND - Compound Not Detected in laboratory analysis.

5 N/L - Not Listed in Michigan Part 201 Generic Industrial and Commercial Cleanup Criteria as of June 1999.
N/A - Not Available or Not Applicable, but contaminant has been LISTED as of June 1999.

6 D - Concentration constituting cleanup criteria exceeds 100 % in soil hence it is reduced to 100 %.

7 ID - Inadequate Data. There is not enough health risk data to develop criterion for this contaminant.

8 L - Criteria developed using the U.S. EPA integrated uptake Biokinetic Model for children. No risk assessment method is currently available to evaluate lead toxicity in adults. Higher level may be acceptable subject to U.S. EPA and State of Michigan review and approval procedure.

9 IP - Development of generic GSI value in process but not yet complete.

10 NP, NO - Contaminant discovered at the time of the 1990 ROD but subsequently shown (by subsequent sampling and analysis) as Not Present, Naturally Occurring, or well below soil, air, groundwater, or surface water cleanup criteria. See Table 3 for more detail.

11 M - Method Detection Limit is cleanup criterion. The Method Detection Limit is the lowest value accepted by the State of Michigan that laboratory equipment can measure. If the Part 201 cleanup criterion is lower than what the laboratory can detect then the MDL becomes the cleanup standard.

12 Alkylbenzene isomers are compounds related to Toluene, Ethylbenzene, and Isopropylbenzene (all are "Alkyl benzenes").

13 G - Soil criteria for GSI protection is dependent on hardness of water in the area. X - The GSI criterion shown is not protective for surface water that is used as a drinking water source.

14 C - Soil criteria is based on contaminant - specific generic soil saturation concentration to insure a more protective cleanup goal. Soil criterion may be modified based on an acceptable site - specific demonstration subject to U.S. EPA/MDEQ review and approval

**DATA QUALIFIER LEGEND**

When chemical analysis data is submitted to U.S. EPA limitations of analytical equipment must be noted with results so an accurate scrutiny can be performed. These limitations are shown as qualifiers noted as letters next to numerical values. Explanations of these qualifiers are as follows:

** Not found in duplicate analysis; *** Less than 10 times the concentration found in lab field or background blanks; **** Compound is unknown in the sense that there were detections of organic chemicals but specific identification of a certain compound or isomer detected is unknown.

J - Signifies a value that was estimated. This means that the compound was detected by the analytical equipment but the value shown may not be able to be reproduced exactly if the analysis were repeated.

B - Signifies a compound that was also detected in a blank. A blank is a 'clean' sample prepared in the laboratory carried with field samples transported and stored. If contamination is found in a blank there is a possibility that contamination may be from a source other than what was sampled (such as through faulty sampling storage transportation or laboratory procedures).

D - Signifies that the sample shown had to be diluted for the lab equipment to show results that are reproducible.

E - Estimated value due to deviations discovered in lab quality control (QC) procedure.

**TABLE 2 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS) - O.U. #1 LAGOON AREA - BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| Acenapthene | 3,800 | 1,300 | 19 | 4200 S [7] | ND[9] | 20 |
| Acenapthylene [17] | 75 | 26 | ID[12] | 3900 S [7] | ND | 21 |
| Acetone | 2,100 | 730 | 1,700 | 31,000,000 | ND | 5,100; 81,000 E |
| Aniline (cc) | 610 | 150 | IP [14] | 370,000 | ND | 10,000 |
| Anthracene | 43 S [7] | 43 S [7] | ID [12] | 43 S [7] | ND | 14 J |
| Azobenzene (cc) | 32 | 7.7 | NA [5] | 410 | ND | 420 @ PW-40 (7/93) |
| Benzene (cc) | 5 A [8] | 5 A [8] | 200 X[13] | 9,400 | 8,000 | 65,000 |
| Benzeneacetic acid [17] | N/L [11] | NOT LISTED | | | ND | 140 J |
| Benzidine (cc) | 0.3 M [10] | 0.3 M [10] | ID [12] | 6.8 | ND | 12,000 @ MW-106 (6/92) |
| Benzo(a)anthracene | 5 M [10] | 5 M [10] | NA [5] | 5 M [10] | ND | 19 J |
| Benzo(a)pyrene [17] | 5 M [10] | 5 M [10] | ID[12] | 5 M [10] | ND | 230 |
| 1,2,3-Benzothiadiazole [17] | N/L [11] | NOT LISTED | | | ND | 1,300 J |
| Benzyl Alcohol | 29,000 | 10,000 | NA [5] | 44,000,000 S[7] | ND | 310 @ PW-39 (6/92) |
| Bis(2-ethylhexyl)phthalate | 6 A [8] | 6 A [8] | 32 | 47 | ND | 4,000 J |
| Carbon Disulfide | 2,300 | 800 | ID [12] | 1,100,000 | ND | 1,000 |
| 2-Chloroaniline | N/L [11] | NOT LISTED | | | ND | 63,000 |
| 4-Chloroaniline | N/L [11] | NOT LISTED | | | ND | 62 @ MW-62 (7/93) |
| Chlorobenzene | 100 A [8] | 100 A [8] | 47 | 68,000 | ND | 920 |
| Chloroform | 100 A,W [8,15] | 100 A,W [8,15] | 170 X[13] | 96,000 | ND | 4.8 @ MW-60 (6/94) |

**TABLE 2 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS) - O.U. #1 LAGOON AREA - BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| (3-chlorophenyl)(4-chlorophenyl) - methanone | N/L [11] | NOT LISTED | | | ND | 700 J |
| Chrysene | 5 M [10] | 5 M [10] | ID [12] | 5 M [10] | ND | 19 J |
| Dibenzofuran [17] | ID [12] | ID [12] | 4 | ID[12] | ND | 18 J |
| 3,3'-Dichlorobenzidine (and isomers) (cc) | 7.7 | 1.9 | 0.3 M,X [10,13] | 270 | ND | 2,600 |
| 1,2-Dichlorobenzene | 600 A [8] | 600 A [8] | 16 | 160,000 S [7] | ND | 400 |
| 1,2-Dichloroethane | 5 A [8] | 5 A [8] | 360 X[13] | 11,000 | ND | 110 |
| 1,1-Dichloroethylene (ethene) | 7 A [8] | 7 A [8] | 65 X[13] | 9000 | ND | 34 J @ PW-33 (6/94) |
| 1,2-Dichloroethylene (ethene) | 70 A [8] | 70 A [8] | ID [12] | 170,000 | ND | 2,400 @ PW-33 (6/94) |
| N,N - Dimethylformamide | 2,000 | 700 | NA [5] | 130,000,000 | ND | 450 J |
| Dimethyl phthalate | 210,000 | 73,000 | NA [5] | 4,200,000 S [7] | ND | 120 J |
| Dimethylbenzenamine [17] | N/L [11] | NOT LISTED | | | ND | 780 J |
| Dimethylnapthalene [17] | N/L [11] | NOT LISTED | | | ND | 52 J |
| Di-n-Butylphthalate | 2,500 | 880 | 9.7 | 11,000 S [7] | ND | 180 @ PW-40 (11/93) |
| Di-n-Octylphthalate | 380 | 130 | ID [12] | 250 | ND | 459 @ PW-40 (6/92) |
| 1,1'-Diphenyl- 2,2-Diamine | N/L [11] | NOT LISTED | | | ND | 3,200 J |
| 2,3-Dihydrodimethyl-1H-Indene | N/L [11] | NOT LISTED | | | ND | 42 J |
| Ethylbenzene | 74 E [14] | 74 E [14] | 18 | 170,000 S [7] | ND | 340 @ PW-41 (9/92) |

**TABLE 2 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS) - O.U. #1 LAGOON AREA - BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| Fluoranthene | 210 S [7] | 210 S[7] | 1.6 | 210 S [7] | ND | 16 J |
| Fluorine [17] | 2,000 A E [8] | 2,000 A E [8] | NA [5] | 13,000,000 | ND | 16 J |
| 2-Hydroxybenzonitrile [17] | N/L [11] | NOT LISTED | | | ND | 44 J |
| 4-hydroxy-4-methyl-2-pentanone[17] | N/L [11] | NOT LISTED | | | ND | 190 J |
| Isophorone | 3,700 | 900 | 570 X [13] | 1,100,000 | ND | 1,400 |
| 2-Methylnapthalane | 750 | 260 | ID [12] | 32,000 | ND | 480 |
| 2-Methylphenol | 1,000 | 370 | 82 | 710,000 | ND | 470 |
| 4-Methylphenol | 100 | 37 | ID [12] | 75,000 | ND | 170 |
| 1-Methoxynitrobenzene [17] | N/L [11] | NOT LISTED | | | ND | 22,000 J |
| 1-Methylnaphthalene [17] | N/L [11] | NOT LISTED | | | ND | 490 J |
| Methoxybenzeneamine [17] | N/L [11] | NOT LISTED | | | ND | 21,000 J |
| Methylene Chloride | 5 A [8] | 5 A [8] | 940 X[13] | 110,000 | ND | 5,820 @ PW-38 (6/92) |
| N-nitroso-Di-n-Propylamine | 5 M [10] | 5 M [10] | NA [5] | 220 | ND | 30 @ PW-34 (12/92) |
| Naphthalene | 750 | 260 | 13 | 31,000 S [7] | ND | 650 |
| Nitrobenzene | 9.6 | 5 M [10] | 180 X [13] | 9,600 | ND | 6,600 |
| Phenanthrene | 75 | 26 | 5 M [10] | 1,000 S [7] | ND | 19 J |
| Phenol | 13,000 | 4,400 | 210 | 28,000,000 | ND | 140; 170 J |
| Pyrene | 140 S [7] | 140 S [7] | ID [12] | 140 S [7] | ND | 27 |
| Sulfur [17] | N/L [11] | NOT LISTED | | | ND | 1,800 J |

**TABLE 2 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS) - O.U. #1 LAGOON AREA - BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| Tetrachloroethylene | 5 A [8] | 5 A [8] | 45 X[13] | 5,100 | ND | 18,000 |
| Toluene | 790 E [8] | 790 E [8] | 140 | 530,000 S [7] | 3,000 J | 280,000 |
| 1,2,4-Trichlorobenzene | 70 A[8] | 70 A[8] | 30 | 15,000 | ND | 56 J |
| Trichloro-1-propene isomer [17] | N/L [11] | NOT LISTED | | | ND | 36 J |
| Trichloroethylene | 5 A [8] | 5 A [8] | 200 X[13] | 11,000 | ND | 2,100 @ PW-33 (6/94) |
| 3,3,5-Trimethylcyclohexanone | N/L [11] | NOT LISTED | | | ND | 31,000 J |
| Trimp (trimethylphenols) | N/L [11] | NOT LISTED | | | ND | 2,000 J |
| 1,2,4-Trithiolane [17] | N/L [11] | NOT LISTED | | | ND | 420 J |
| 1,3,5-Trithlane [17] | N/L [11] | NOT LISTED | | | ND | 100 J |
| Unknowns **** | N/L [11] | NOT LISTED | | | ND | 100,500 |
| Vinyl chloride | 2 A [8] | 2 A [8] | 15 | 290 | ND | 1,000 |
| Xylenes (total) | 280 E [8] | 280 E [8] | 35 | 190,000 S [7] | 8,000 | 580 @ PW-41 (5/91) |
| Aluminum | 50 | 50 | NA [5] | 70,000,000 | 192 | 23,200 |
| Antimony [17] | 6 A [8] | 6 A [8] | ID [12] | 75,000 | 61.3 | 61 |
| Arsenic | 50 A [8] | 50 A [8] | 150 X [13] | 4,700 | 4.8 J | 74 |
| Barium | 2,000 A [8] | 2,000 A [8] | 190 | 15,000,000 | 23.2 J | 174 J |
| Beryllium | 4 A [8] | 4 A [8] | G [18] | 1,100,000 | ND | 14 @ MW-72 (12/92) |
| Cadmium | 5 A [8] | 5 A [8] | G[18], X[13] | 210,000 | 5.3 | 120,000 @ IL-01 (3/93) |
| Calcium [17] | (no threat to human health and the environment) | | | | 43,700 | 345,800 @ PW-41 (10/91) |

**TABLE 2 - CONTAMINANTS IN GROUNDWATER[1] AND GROUNDWATER CLEANUP CRITERIA (PERFORMANCE STANDARDS) - O.U. #1 LAGOON AREA - BOFORS-NOBEL SITE**

| CONTAMINANT | PART 201 INDUSTRIAL DRINKING WATER CRITERIA[2] (ppb) | PART 201 RESIDENTIAL DRINKING WATER CRITERIA [3] (ppb) | PART 201 GENERIC GSI CLEANUP CRITERIA [4] (ppb) | PART 201 GROUNDWATER CONTACT CRITERIA [5] (ppb) | BACKGROUND[6] (ppb) | MAX. CONTAMINANT CONCENTRATION (ppb) IN 1990 ROD OR REMEDIAL DESIGN (month/yr) [1] |
|---|---|---|---|---|---|---|
| Chromium (VI) | 100 A [8] | 100 A [8] | 11 | 1,000,000 | 28.2 | 74 @ MW-72 (12/92) |
| Cobalt | 100 | 50 M [10] | 100 | 1,100,000 | 10 | 38 @ MW-72 (12/92) |
| Copper | 1,000 E [8] | 1,000 E [8] | G[18] | 8,100,000 | 64.7 | 120 @ MW-72 (12/92) |
| Iron [17] | 300 E [8] | 300 E [8] | NA [5] | ID [12] | 768 | 35,400 |
| Lead | 4 L [19] | 4 L [19] | G,X [13,18] | ID [12] | 7.3 | 8,800 @ MW-110 (9/92) |
| Magnesium [17] | 1,200,000 | 420,000 | NA [5] | 1,000,000,000 D[20] | 13,200 | 85,000 @ MW-106 (9/92) |
| Manganese | 50 E [8] | 50 E [8] | G,X [13,18] | 10,000,000 | 34 | 5,390 |
| Mercury | 2 A [8] | 2 A [8] | 0.2 M [15] | 56 S[7] | 0.2 | 1.3 |
| Nickel [17] | 100 A [8] | 100 A [8] | G[18] | 16,000,000 | 22.9 J | 810 @ MW-110 (9/92) |
| Potassium [17] | (no threat to human health and the environment) | | | | 1930 J | 16,500 |
| Selenium | 50 A [8] | 50 A [8] | 5 | 1,100,000 | 3.6 J | 14.7 |
| Silver | 98 | 34 | 0.2 M [15] | 1,000,000 | 12.9 | 16,000 @ MW-72 (12/92) |
| Sodium [17] | 450,000 | 160,000 | NA [5] | 1,000,000,000 D[20] | 1430 | 1,610,000 |
| Thallium | 2 A [8] | 2 A [8] | 3.7 X [13] | 14,000 | ND | 30 @ MW-110 (9/92) |
| Vanadium | 180 | 64 | 12 | 1,900,000 | 12.7 J | 412 |
| Zinc | 5,000 E [8] | 2,400 | G[18] | 70,000,000 | 88.7 | 210,000 @ MW-72 (12/92) |

**FOOTNOTES AND LEGEND FOR TABLE 2**

(cc) Baseline risk assessment identified this contaminant as presenting a major Site risk. Baseline risk assessment did not identify any inorganic contaminants as contaminants of concern.

1 Data taken from Record of Decision and Landfill Remedy Remedial Design. Maximums represent either the maximum shown in the ROD, or the maximum concentration discovered during RD quarterly groundwater monitoring from mid-1992 to mid-1994. Maximum concentrations that have been noted with location and (month/year) are RD data. All other maximums are 1990 ROD and RI data.

2 Industrial Drinking Water Standard is the cleanup criteria that are applicable to groundwater unless appropriate deed restrictions can not be obtained for future industrial land use, in which case criteria for future residential land use would apply for groundwater.

3 Residential Drinking Water Standard is the cleanup criteria that are applicable to groundwater for future residential land use.

4 Groundwater - Surface Water Interface (GSI) Criteria are contaminant concentrations in groundwater which, if not exceeded, are protective of a surface water body that receives such contaminated groundwater discharge. These GSI limits must be maintained to insure protection of Big Black Creek.

5 Groundwater Contact Criteria are contaminant concentrations in groundwater which, if not exceeded, are protective of human health in the event of inadvertent human direct contact with such contaminated groundwater.

6 BACKGROUND - Background concentration taken from sample in relatively "clean" Site area as shown in the February 1990 Remedial Investigation (RI) report. For cleanup standards noted by a 'B', background concentrations may be used instead of the value shown.

7 S - Criterion is based on the chemical specific water solubility limit.

8 A - State of Michigan Drinking Water Criterion established pursuant to Section 5 of the Safe Drinking Water Act, Act No. 399 of the Public Acts of 1976;
E - Criterion is the aesthetic drinking water value, as required by Sec. 20120(1)(5).

9 ND - Compound Not Detected in laboratory analysis.

10 M - Criterion is below the Method Detection Limit, therefore, the criterion defaults to the MDL. The Method Detection Limit is the lowest value accepted by the State of Michigan that laboratory equipment can measure. If the Part 201 cleanup criterion is lower than what the laboratory can detect, then the MDL becomes the cleanup criterion.

11 N/L - Not Listed in Michigan Part 201 Generic Industrial and Commercial Cleanup Criteria.

12 ID - Inadequate Data. The State of Michigan does not have enough health risk data to develop criterion for this contaminant.

13 X - The GSI criterion shown is not protective for surface water that is used as a drinking water source.

14 IP - Development of generic GSI value in process but not yet complete.

15 W - Concentrations of trihalomethanes in groundwater must be added together to determine compliance with the Drinking Water Standard of 100 ppb.

16 NA - Not Available.

17 Contaminant discovered at the time of the 1990 ROD, but subsequently shown (by subsequent sampling and analysis) as not present, naturally occurring, or well below soil, air, groundwater, or surface water cleanup standard after appropriate U.S. EPA and MDEQ review and approval. See Table 3 for more detail.

18 H - Standard is dependent on "hardness" of groundwater; G - GSI cleanup criterion is dependent upon water hardness in the area.

19 L - For Lead, higher concentrations may be acceptable and criteria may be modified based on an acceptable site-specific demonstration subject to U.S. EPA/MDEQ review and approval.

20 D - Calculated groundwater criterion exceeds 100 % and is reduced to 100 %. Site - specific evaluation of contaminant status and adverse impacts subject to U.S. EPA/MDEQ review and approval may be required.

**DATA QUALIFIER LEGEND**

When chemical analysis data is submitted to U.S. EPA, limitations of analytical equipment must be noted with results so an accurate scrutiny can be performed. These limitations are shown as qualifiers, noted as letters next to numerical values. Explanations of these qualifiers are as follows:

**** Compound is noted as "unknown" because there were detections of organic chemicals, but specific identification of specific compound or isomer detected is unknown.

J - Signifies a value that was estimated. This means that the compound was detected by the analytical equipment but the value shown may not be able to be reproduced exactly if the analysis were repeated.

B - Signifies a compound that was also detected in a blank. A blank is a 'clean' sample prepared in the laboratory, carried with field samples, transported, and stored. If contamination is found in a blank, there is a possibility that contamination may be from a source other than what was sampled (such as through faulty sampling, storage, transportation, or laboratory procedures).

D - Signifies that the sample shown had to be diluted for the lab equipment to show results that are reproducible.

E - Estimated value due to deviations discovered in lab quality control (QC) procedure.

## TABLE 3 - COMPARISON OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION) [2] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION) [2] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| Acenapthene | Groundwater | 20 ppb (LW-3)[2] | ND | < 50 U ppb (W-1; MW-43) [6] |
| | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm (L-9) |
| Acenapthylene | Groundwater | 21 ppb (LW-3)[2] | ND [5] | < 50 U ppb (W-1; MW-43) [6] |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm (L-10) |
| Acetone | Groundwater | 81,000 ppb (WC-2)[2] | ND [5] | 25,000 ppb (W-1; MW-43) [6] |
| | Soil/Sludge | 0.091 ppm (L-9) | N/A[14] | < 240 U ppm (LS-9) |
| Alkyl benzene isomers [7] | Groundwater | ND [5] | | N/A[14] |
| | Soil/Sludge | 148,000 J ppm (L-9) | | N/A[14] |
| Aniline (cc) | Groundwater | 10,000 ppb (WC-27) | 780 D ppb (PW-34) | 100 ppb (W-1; MW-43) |
| | Soil/Sludge | 3,900 ppm (L-9) | N/A[14] | < 310 U ppm (L-9) |
| Anthracene | Groundwater | 14 J ppb (LW-3) | ND [5] | < 50 U ppb (W-1; MW-43) |
| Footnote (13) | Soil/Sludge | 1.1 J ppm (SS-38) | N/A[14] | < 150 U ppm (L-10) |
| Azobenzene (cc) | Groundwater | 20 J ppb (PW-41) | ND [5] | N/A[14] |
| | Soil/Sludge | 12,000 ppm (L-3) | N/A[14] | N/A[14] |
| Azoxybenzene | Groundwater | ND [5] | | |
| | Soil/Sludge | 690 J ppm (L-3) | N/A[14] | N/A[14] |
| Benzene | Groundwater | 65,000 ppb (WC-27) | 9400 ppb (PW-34) | 39,000 ppb (W-1; MW-43) |
| | Soil/Sludge | 980 ppm (L-3) | N/A[14] | 84 ppm (L-9) |
| Benzeneacetic Acid | Groundwater | 140 J ppb (WC-2) [8] | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A[14] |
| Benzidine (cc) | Groundwater | 1300 ppb (MW-108) | 1600 D ppb (MW-60) | 110 ppb (P-108 D) |
| | Soil/Sludge | 3,400 ppm (L-3) | N/A[14] | < 950 U ppm (L-9) |
| Benzo(a)anthracene | Groundwater | 19 J ppb (LW-3) | ND [5] | < 50 U ppb (MW-43) |
| Footnote (13) | Soil/Sludge | 4.3 ppm (SS-38) | N/A[14] | < 310 U ppm (LS-9) |
| Benzo(a)pyrene | Groundwater | 230 ppb (LW-3) | ND [5] | < 50 U ppb (W-1; MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 150 U ppm (L-10) |
| Benzothiazole isomer | Groundwater | ND [9] | N/A | N/A[14] |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A[14] |
| 1,2,3 - Benzothiadiazole | Groundwater | 1300 J ppb (WC-27) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |

## TABLE 3 - COMPARISON OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| Benzyl Alcohol | Groundwater | 5 J ppb (LW-3) | ND [5] | N/A |
| Footnote (13) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| Bis(2-ethylhexyl)phthalate | Groundwater | 4000 J ppb (MW-7)<br>10 J ppb (MW-102) | 21 BJ ppb (P 108)<br>170 E ppb (PW 36)<br>110 ppb (PW 37) | < 5 U ppb (MW-60)<br>< 5 U ppb (P 103)<br>< 5 U ppb (P 108)<br>< 5 UJ ppb (MW 110) |
| | Soil/Sludge | 119 J ppm (SS-57) | N/A[14] | < 310 U ppm (L-9) |
| Bromodichloromethane | Groundwater | ND [5] | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| Bromoform | Groundwater | ND [5] | ND [5] | < 5 UJ ppb (MW-44)<br>< 500 U ppb (MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 24 ppm (L-9) |
| Bromomethane | Groundwater | ND [5] | ND [5] | < 500 U ppb (MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| 2-Butanone (MEK) | Groundwater | ND [5] | ND [5] | < 25,000 ppb (MW-43) |
| | Soil/Sludge | 0.025 ppm (L-9) | N/A [14] | < 240 ppm (L-9) |
| Carbon Disulfide | Groundwater | 1000 ppb (LW-3) | ND [5] | < 2,500 U ppb (MW-43) |
| | Soil/Sludge | ND [5] | N/A[14] | < 240 U ppm (L-9) |
| Carbon Tetrachloride | Groundwater | ND [5] | ND [5] | < 500 U ppb (MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| 2-Chloroaniline | Groundwater | 63,000 ppb (WC-27) | 1,600 D ppb (MW-62) | < 50 U ppb (MW-43)<br>< 5 U ppb (MW-60) |
| | Soil/Sludge | 2,300 ppm (L-9) | N/A[14] | < 310 U ppm (L-9) |
| 4-Chloroaniline | Groundwater | 42 J ppb (MW-102) | 34 ppb (MW-62) | < 200 U ppb (MW-43) |
| | Soil/Sludge | ND [5] | N/A[14] | < 1200 U ppm (L-9) |
| Chlorobenzene | Groundwater | 920 ppb (LW-4) | 320 ppb (PW-33) | < 500 U ppb (MW-43)<br>< 1 UJ ppb (MW-110)<br>< 6.1 UJ ppb (MW-44; 100') |
| | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| Chloroform | Groundwater | ND [5] | 4.8 ppb (MW-60) | < 500 U ppb (MW-43)<br>< 1 U ppb (MW-60) |
| | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| (3-Chlorophenyl) (4-Chlorophenyl) Methanone | Groundwater | 700 J (WC-27) | N/A | N/A |
| Footnote (13) | Soil/Sludge | 6,200 ppm (L-9) | N/A[14] | N/A |

## TABLE 3 - COMPARISON OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION) [2] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION) [2] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| Chrysene | Groundwater | 19 J ppb (LW-3) | 1 J ppb (PW-39) | < 50 U ppb (MW-43) |
| Footnote (13) | Soil/Sludge | 6.5 ppm (SS-38) | N/A[14] | < 310 U ppm (L-9) |
| Dibenzofuran | Groundwater | 18 J ppb (LW-3) | ND [5] | < 50 U ppm (MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm (L-9) |
| Dibromochloromethane | Groundwater | ND [5] | ND [5] | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| Dichlorobromomethane | Groundwater | ND [5] | ND [5] | < 500 U ppb (MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| 3,3'-Dichlorobenzidine (and isomers) (cc) | Groundwater | 1,900 ppb (WC-27); 2,600 ppb (PW-41) | 280 D ppb (PW-34) | < 200 U ppb MW-43<br>47 ppb (MW-110)<br>46 ppb (OW-108) |
| | Soil/Sludge | 11,000 ppm (L-9) | N/A[14] | 4,900 ppm (L-9) |
| 1,2-Dichlorobenzene | Groundwater | 400 ppb (LW-3) | 100 ppb (PW-39) | < 500 U ppb (MW-43) |
| | Soil/Sludge | 7.5 J ppm (SS-57) | N/A[14] | < 24 U ppm (L-9) |
| 1,1-Dichloroethane | Groundwater | ND [5] | ND [5] | < 500 U ppb (MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| 1,2-Dichloroethane | Groundwater | 110 ppb (PW-33) | ND [5] | < 500 U ppb (MW-43)<br>< 1 U ppb (MW-110) |
| | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| 1,1-Dichloroethene | Groundwater | ND [5] | 34 J ppb (PW-33) | < 500 U ppb (MW-43) |
| | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| 1,2-Dichloroethene (and isomers) | Groundwater | 1,900 ppb (LW-3) | 2,400 (PW-33) | < 1,000 U ppb (MW-43)<br>< 2 UJ ppb (MW-110) |
| | Soil/Sludge | ND [5] | N/A[14] | N/A |
| 1,2-Dichloropropane | Groundwater | ND [5] | ND [5] | < 500 U ppb (MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| 1,3-Dichloropropene (& isomers) | Groundwater | ND [5] | ND [5] | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| N,N - Dimethylformamide | Groundwater | 450 J ppb (PW-33) | 27 ppb (PW-30)<br>36 ppb (PW-30) | N/A |
| Footnote (13) | Soil/Sludge | ND [5] | N/A[14] | N/A |

## TABLE 3 - COMPARISON OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| Dimethyl phthalate | Groundwater | 120 J ppb (LW-4) | ND [5] | < 50 U ppb (MW-43) |
| | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm (L-9) |
| Dimethylbenzenamine | Groundwater | 780 J ppb (LW-4) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| Dimethylnapthalene | Groundwater | 52 J ppb (WC-2) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| Di-n-Butylphthalate | Groundwater | 5 J ppb (MW-51) | 1 BJ ppb (MW-41)<br>1 BJ ppb (MW-63)<br>1 J ppb (P-108)<br>1 J ppb (PW-36)<br>1 J ppb (PW-40) | < 50 UJ ppb (MW-44)<br>< 50 U ppb (MW-43) |
| | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm (L-9) |
| Di-n-Octylphthalate | Groundwater | ND [5] | 36 ppb (PW-31);<br>23 ppb (MW-63);<br>459 ppb @ PW-40-01 (Q 1 (6/92)) | < 50 UJ ppb (MW-44)<br>< 50 U ppb (MW-43) |
| | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm L-9 |
| 2,4-Dinitrophenol | Groundwater | ND [5] | ND [5] | < 200 UJ ppb (MW-44)<br>< 200 U ppb (MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 1600 U ppm (L-9) |
| 1,1'-Diphenyl- 2,2-Diamine | Groundwater | 3,200 J ppb (MW-106) | 12 ppb (MW-62) | N/A |
| Footnote (13) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| 2,3-Dihydrodimethyl-1H-Indene | Groundwater | 42 J ppb (WC-2) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| Ethylbenzene | Groundwater | 3 J ppb (MW-110) | 120 ppb (PW-41) | < 500 U ppb (MW-43) |
| | Soil/Sludge | 9.2 ppm (L-6) | N/A[14] | < 24 U ppm (L-9) |
| Fluoranthene | Groundwater | 16 J ppb (LW-3) | ND [5] | < 50 UJ ppb (MW-44);<br>< 50 U ppb (MW-43) |
| Footnote (13) | Soil/Sludge | 14 ppm (SS-38) | N/A[14] | < 310 U ppm (L-9) |
| Fluorine | Groundwater | 16 J ppb (LW-3) | ND [5] | < 50 U ppb (MW-43) |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm (L-9) |
| 2-Hydroxybenzonitrile | Groundwater | 44 J ppb (MW-102) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |

## TABLE 3 - COMPARISON OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| 4-hydroxy-4-methyl-2-pentanone | Groundwater | 190 J ppb (WC-2) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| Isophorone | Groundwater | 1,400 ppb (LW-4) | 7.2 ppb (PW-33) | < 5 UJ ppb (MW-110; 55') |
| | Soil/Sludge | ND [5] | N/A[14] | < 310 J ppm (L-9) |
| 2-Methylnapthalane | Groundwater | 480 ppb (WC-2) | ND [5] | < 50 U ppb (MW-43) |
| Footnote (13) | Soil/Sludge | 35 J ppb (SS-22) | N/A[14] | < 310 U ppm (L-9) |
| 2-Methylphenol | Groundwater | 470 ppb (WC-2) | 21 PW-34 | < 5 U ppb (P-108; 60') |
| | Soil/Sludge | 5.7 J ppm (SS-57) | N/A[14] | < 310 U ppm (L-9) |
| 4-Methylphenol | Groundwater | 170 ppb (WC-2) | 11 ppb (PW-39) | < 5 UJ ppb (MW-110; 55') |
| | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm (L-9) |
| 1-Methoxynitrobenzene | Groundwater | 22,000 J ppb (WC-27) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| 1-Methylnaphthalene | Groundwater | 490 J ppb (WC-2) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| 2-Methylnaphthalene | Groundwater | 480 ppb (WC-2) | ND [5] | < 50 U ppb (MW-43) |
| | Soil/Sludge | 35 J ppb (SS-22) | N/A[14] | < 310 U ppm (L-9) |
| Methoxybenzeneamine | Groundwater | 21,000 J ppb (LW-1) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| Methylene Chloride (cc) (Dichloromethane) | Groundwater | 1400 J ppb (WC-2) | 5.2 J ppb (PW-41) | < 500 U ppb (MW-43) |
| | Soil/Sludge | 2.2 ppm (L-6) | N/A[14] | < 24 U ppm (L-9) |
| N-nitroso-Di-n-Propylamine | Groundwater | 6 J ppb (MW-102) | ND [5] | < 50 U ppb (MW-43)<br>< 50 U ppb (MW-44) |
| Footnote (13) | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm L-9 |
| Napthalene | Groundwater | 650 ppb (WC-2) | 1 J ppb (PW-34) | < 5 UJ ppb (P-108; 60')<br>< 50 U ppb (PW-43) |
| | Soil/Sludge | 6.7 J ppm (SS-57) | N/A[14] | < 310 U ppm (L-9) |
| Nitrobenzene | Groundwater | 6,600 ppb (WC-27) | ND [5] | < 50 U ppb (MW-43) |
| | Soil/Sludge | ND [5] | N/A[14] | < 310 U ppm (L-9) |
| Phenanthrene | Groundwater | 19 J ppb (LW-3) | ND [5] | < 50 U ppb (MW-43) |
| | Soil/Sludge | 7 ppm (SS-38) | N/A[14] | < 310 U ppm (L-9) |

## TABLE 3 - COMPARISON OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| Phenol | Groundwater | 170 J ppb (LW-1) | 65 DJ ppb (PW-34) | < 5 U ppb (P-108) |
| | Soil/Sludge | 3.2 J ppm (SS-57) | N/A[14] | < 310 U ppm (L-9) |
| Pyrene | Groundwater | 27 ppb (LW-3) | ND[5] | < 50 U ppb (MW-43) |
| Footnote (13) | Soil/Sludge | 9.9 ppm (SS-38) | N/A[14] | < 310 U ppm (L-9) |
| Sulfur | Groundwater | 1800 J ppb (LW-1) | N/A | N/A |
| Footnote (12) | Soil/Sludge | 8.3 ppm (L-7) | N/A[14] | N/A |
| 1,1' - Sulfonyl - bis (2-Methyl) Benzene | Groundwater | ND[5] | 12 ppb (PW-41) | N/A |
| Footnote (13) | Soil/Sludge | 82 ppm (L-10) | N/A[14] | N/A |
| Tetrachloroethylene | Groundwater | 18,000 ppb (LW-3) | 4,100 ppb (PW-39) | < 500 U ppb (MW-43) |
| | Soil/Sludge | 0.68 ppm (L-8) | N/A[14] | < 0.021 U ppm (L-8) |
| 1,1,2,2-Tetrachloroethane | Groundwater | ND[5] | 9 J ppb (PW-38) | < 1 U ppb (OW-108) |
| | Soil/Sludge | ND[5] | N/A[14] | < 24 U ppm (L-9) |
| Toluene (cc) | Groundwater | 280,000 ppb (WC-27) | 2,900 ppb (PW-39) | 10,000 ppb (MW-43) |
| | Soil/Sludge | 1,600 ppm (L-9) | N/A[14] | 770 ppm (L-9) |
| 1,2,4-Trichlorobenzene | Groundwater | 56 J ppb (LW-1) | 8.9 ppb (PW-38) | < 500 U ppb (MW-43)<br>< 1 U ppb (OW-108; 20') |
| | Soil/Sludge | 250 ppm (L-9) | N/A[14] | < 310 U ppm (L-9) |
| Trichloro-1-propene isomer | Groundwater | 36 J ppb (MW-105) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND[5] | N/A[14] | N/A |
| 1,1,1-Trichloroethane | Groundwater | ND[5] | ND[5] | < 500 U ppb (MW-43)<br>< 1 U ppb (ALL OTHER) |
| Footnote (12) | Soil/Sludge | ND[5] | N/A[14] | < 24 U ppm (L-9) |
| 1,1,2-Trichloroethane | Groundwater | ND[5] | ND[5] | < 500 U ppb (MW-43)<br>< 1 U ppb (ALL OTHER) |
| Footnote (12) | Soil/Sludge | ND[5] | N/A[14] | < 24 U ppm (L-9) |
| Trichloroethylene | Groundwater | 43 ppb (PW-41) | 2,100 ppb (PW-33) | < 500 U ppb (MW-43)<br>4.8 ppb (MW-60)<br>< 1 UJ ppb (MW-110) |
| | Soil/Sludge | ND[5] | N/A[14] | < 24 U ppm (L-9) |
| 3,3,5-Trimethylcyclohexanone | Groundwater | 31 J ppb (MW-106) | 600 D ppb (PW-33) | N/A |
| Footnote (13) | Soil/Sludge | ND[5] | N/A[14] | N/A |

## TABLE 3 - COMPARISON OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION) [2] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION) [2] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| Trimp (trimethylphenols) | Groundwater | 2,000 J ppb (LW-4) | 260 D ppb (PW-33) | N/A |
| Footnote (13) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| 1,2,4-Trithiolane | Groundwater | 420 J ppb (WC-27) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| 1,3,5-Trithlane | Groundwater | 100 J ppb (WC-27) | N/A | N/A |
| Footnote (12) | Soil/Sludge | ND [5] | N/A[14] | N/A |
| Unknowns **** | Groundwater | 100,500 ppb (WC-27)<br>100,500 J ppb (LW-1) | 70 ppb (PW-31) | N/A |
| | Soil/Sludge | 503 J ppm (L-6) | | |
| Vinyl Chloride | Groundwater | 1,000 ppb (PW-33) | 760 ppb (PW-33) | < 1 UJ ppb (MW-110; 55') |
| | Soil/Sludge | ND [5] | N/A[14] | < 24 U ppm (L-9) |
| Xylenes (total) | Groundwater | 100 ppb (PW-41) | 50 ppb (PW-41) | < 3 UJ ppb (P-108; 60')<br>< 1500 U ppb (MW-43) |
| | Soil/Sludge | 58 ppm (L-6) | N/A[14] | < 71 U ppm (L-9) |
| Aluminum | Groundwater | 23,200 ppb (WC-27) | 6,100 ppb (3/93) @ MW-104 | N/A |
| | Soil/Sludge | 7920 ppm (L-5)<br>3770 ppm BKGD [10] | | N/A |
| Antimony | Groundwater | 61 ppb (MW-48) | ND [5] | N/A |
| Footnote (12) | Soil/Sludge | 25 ppm (L-1)<br>ND [5] BKGD [10] | | N/A |
| Arsenic | Groundwater | 74 ppb (WC-27) | 13 ppb (9/92) @ MW-110 | 1.2 ppb (P-103) [11]<br>< 1 U ppb (MW-43) |
| | Soil/Sludge | 44 ppm (L-1)<br>1.7 ppm BKGD [10] | | N/A |
| Barium | Groundwater | 174 J ppb (PW-33) | 64 ppb (12/92) @ MW-72 | < 10 UJ ppb (MW-110; 55')<br>65 ppb (MW-60) |
| | Soil/Sludge | 85 ppm (L-8)<br>12.6 ppm BKGD [10] | | N/A |

## TABLE 3 - COMPARISON OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION)[2] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| Beryllium | Groundwater | ND [5] | 14 ppb (12/92) @ MW-72 | N/A |
| | Soil/Sludge | 2.4 ppm (L-10)<br>ND [5] BKGD [10] | | N/A |
| Cadmium | Groundwater | 5.3 ppb (MW-48) | 120,000 ppb (3/93) @ IL-01 | < 0.2 U ppb (ALL) |
| | Soil/Sludge | 42.4 ppm (L-1)<br>ND [5] BKGD [10] | | N/A |
| Calcium | Groundwater | 178,000 ppb (MW-106) | 320,000 ppb (9/92) @ MW-106 | 96 ppm (WC-1S) |
| Footnote (12) | Soil/Sludge | 271,000 ppm (L-10)<br>109 ppm BKGD [10] | | N/A |
| Chromium | Groundwater | 23.6 ppb (MW-5) | 74 ppb (12/92) @ MW-72 | < 50 U ppb (ALL) |
| | Soil/Sludge | 916 ppm (L-1)<br>2.2 ppm BKGD [10] | | N/A |
| Cobalt | Groundwater | 13 J ppb (WC-27) | 38 ppb (12/92) @ MW-72 | N/A |
| Footnote (13) | Soil/Sludge | 36.7 ppm (L-1)<br>2.2 ppm BKGD [10] | | N/A |
| Copper | Groundwater | 64.7 ppb (MW-101) | 120 ppb (12/92) @ MW-72 | < 10 U ppb (ALL) |
| | Soil/Sludge | 1640 ppm (L-1)<br>ND [5] BKGD [10] | | N/A |
| Iron | Groundwater | 35,400 ppb (LW-1) | 16,000 ppb (9/92) @ MW-104 | < 5 UJ ppm MW-60<br>< 0.51 U ppm MW-43 |
| Footnote (12) | Soil/Sludge | 13,000 ppm (L-9)<br>2,650 ppm BKGD [10] | | N/A |
| Lead | Groundwater | 57.5 ppb (WC-27) | 8,800 ppb (9/92) @ MW-110C | 7 ppb (MW-60) [11]<br>< 1 U ppb MW-43 |
| | Soil/Sludge | 6040 ppm (L-1)<br>3.2 ppm BKGD [10] | | N/A |
| Magnesium | Groundwater | 63,400 ppb (WC-2) | 85000 ppb (9/92) @ MW-106C | 28 ppm (MW-44)<br>13 ppm (MW-43) |
| Footnote (12) | Soil/Sludge | 3,400 ppm (L-8)<br>342 ppm BKGD [10] | | N/A |
| Manganese | Groundwater | 5,390 ppb (WC-2) | 580 ppb (2/92) @ PW-33 | 710 ppb (WC-1) |
| | Soil/Sludge | 2680 ppm (L-1)<br>17.3 ppm BKGD [10] | | N/A |

## TABLE 3 - COMPARISON OF SAMPLING AND ANALYSIS; BOFORS-NOBEL O.U. #1 LAGOON AREA

| CONTAMINANT | MEDIA | OLD RESULT (and SAMPLING LOCATION)[2] YEAR 1990[1] (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION) [2] LANDFILL RD - Q #7 (June1994[3]), or as otherwise noted (ppb or ppm as noted) | NEW RESULT (and SAMPLING LOCATION) [2] YEAR 1997[4] (ppb or ppm as noted) |
|---|---|---|---|---|
| Mercury | Groundwater | 1.3 ppb (WC-27) | 0.3 ppb (12/92) @ MW-72 | < 0.2 U ppb (ALL) |
| | Soil/Sludge | 0.71 ppm (L-3)<br>ND [5] BKGD [10] | | N/A |
| Nickel | Groundwater | 72.9 ppb (WC-27) | 810 ppb (9/92) @ MW-110C | N/A |
| | Soil/Sludge | 15.1 ppm (L-9)<br>ND [5] BKGD [10] | | N/A |
| Potassium | Groundwater | 16,500 ppb (LW-3) | 9,300 ppb (9/92) @ MW-106C | 2.7 ppm MW-44<br>1.9 ppm MW-43 |
| Footnote (12) | Soil/Sludge | 394 ppm L-8<br>86.4 ppm BKGD [10] | | N/A |
| Selenium | Groundwater | 14.7 J ppb (MW-102) | ND [5] | < 2 U ppb ALL |
| | Soil/Sludge | 3.3 ppm (L-3)<br>ND [5] BKGD [10] | | N/A |
| Silver | Groundwater | 15.9 ppb (MW-91) | 16,000 ppb (12/92) @ MW-72-01 | < 0.2 U ppb (ALL) |
| | Soil/Sludge | 15.6 ppm (L-1)<br>ND [5] BKGD [10] | | N/A |
| Sodium | Groundwater | 161,000 ppb (WC-27) | 123,000 ppb (6/92) @ PW-34-01 | 255 ppm (MW-44)<br>136 ppm (MW-43) |
| Footnote (12) | Soil/Sludge | 5,920 ppm (L-3)<br>ND [5] BKGD [10] | | N/A |
| Thallium | Groundwater | ND [5] | 30 ppb (9/92) @ MW-110C-01 | N/A |
| Footnote (13) | Soil/Sludge | ND [5]<br>ND BKGD [10] | | N/A |
| Vanadium | Groundwater | 412 ppb (WC-27) | 39 ppb (12/92) @ MW-72-01 | N/A |
| | Soil/Sludge | 28.6 ppm (L-1)<br>48 ppm BKGD [10] | | N/A |
| Zinc | Groundwater | 3,080 ppb (WC-27) | 210,000 ppb (12/92) @ MW-72-01 | 1,190 ppb (MW-44)<br>650 ppb (MW-60)<br>< 20 U ppb (MW-43) |
| | Soil/Sludge | 91,200 ppm (L-3)<br>12.4 ppm BKGD [10] | | N/A |

**FOOTNOTES AND LEGEND FOR TABLE 3**

(cc) Baseline risk assessment identified this contaminant as presenting a major Site risk. Baseline risk assessment did not identify any inorganic contaminants as contaminants of concern.

1 Data taken from Record of Decision and February 1990 Remedial Investigation (RI) Report. To convert ppb to ppm, divide by 1000 and vice versa (ppm to ppb, multiply by 1000).

2 See Figure 3A - Site Layout and Sampling Locations.

3 Data taken from 7th quarter (June 1994) of quarterly groundwater monitoring performed by USACE for Remedial Design of Landfill Remedy. Although analysis for inorganic contaminants was discontinued after Quarter 4 of the RD monitoring program, maximums prior to June 1994 are noted with (month/year).

4 Data taken from document entitled "Technical Memorandum, Total In-Situ Containment Conceptual Design - Bofors-Nobel Superfund Site", dated September 9, 1997, (the "Tech Memo") available for review in the Administrative Record.

5 ND - Compound Not Detected in laboratory analysis.

6 Sampling location W-1 is in close proximity to monitoring well that was labeled MW-43 for sampling performed for the February 1990 Remedial Investigation (RI) Report.

7 Alkylbenzene isomers are compounds that show laboratory results ("hits") similar to Toluene, Ethylbenzene, and Isopropylbenzene (all are "Alkyl benzenes"). Sampling and analysis during the new Remedial Design and Remedial Action will target specific alkyl benzene contaminants.

8 Tentatively Identified Compound. Compound is noted as such because there were detections of organic chemicals, but specific identification of specific compound or isomer detected is unknown.

9 Benozthiazole isomer was not listed in the RI. This may have been a compound later identified for analysis in the Landfill Remedial Design, but subsequent sampling events did not include this contaminant, and thus may no longer be a concern.

10 BKGD - background; sampling and analysis from a "clean" area of the Site performed during the Remedial Investigation.

11 Portion of inorganic compound or element that is dissolved in groundwater.

12 Contaminant discovered at the time of the 1990 ROD, but subsequently shown (by subsequent sampling and analysis) as not present, naturally occurring, or well below soil, air, groundwater, or surface water cleanup standard after appropriate U.S. EPA and MDEQ review and approval. Monitoring for this contaminant may no longer be necessary.

13 Contaminant will be monitored and, because there is no GSI standard, must either be below laboratory detection limits (ND), or, must be demonstrated as not posing any threat to human health and the environment. This demonstration may include toxicity testing as required.

14 N/A - Not analyzed. There was no chemical analyses performed on lagoon area soil or sludge during the Landfill Remedy Remedial Design.

**DATA QUALIFIER LEGEND**

When chemical analysis data is submitted to U.S. EPA, limitations of analytical equipment must be noted with results so an accurate scrutiny can be performed. These limitations are shown as qualifiers, noted as letters next to numerical values. Explanations of these qualifiers are as follows:

**** Compound is noted as "unknown" because there were detections of organic chemicals, but specific identification of specific compound or isomer detected is unknown.

J - Signifies a value that was estimated. This means that the compound was detected by the analytical equipment but the value shown may not be able to be reproduced exactly if the analysis were repeated.

E - Estimated value due to deviations discovered in lab quality control (QC) procedure.

U - Contract Required Quantitation Limit - This signifies that the value shown with a "U" was the lowest reproducible limit that the laboratory equipment could detect.

D- Diluted sample

## TABLE 4 - RISK IDENTIFIED [1] FOR BOFORS-NOBEL O.U. #1 LAGOON AREA

| EXPOSURE PATHWAY | RESIDENTIAL CARCINOGENIC RISK IDENTIFIED IN 1990 ROD[1] |
|---|---|
| Groundwater | 3.4e-05 to 9.9e-01 [3] |
| Soil Ingestion | 2e-10 to 2e-03 [4] |
| Soil Direct (Dermal) Contact | 7.9e-09 to 1e-05 |
| Air | 7.9e-09 to 1.2e-03 [5] |
| Surface Water (Computer Modeled) | 3.4e-07 to 1e-02 [6] |
| CUMULATIVE (TOTAL) RISK | 3.4 e -05 to 1.0 e-00 |

**FOOTNOTES FOR TABLE 4**

1 Information from September 1990 Record of Decision and February 1990 Remedial Investigation (RI) Report.

2 Risk uses a basis of a 70 year life time. A 1.0 e-06 cancer risk value corresponds to a 1 in 1,000,000 chance that an individual develops cancer as a result of exposure to these concentrations of contaminants over a period of 70 years. Similarly, 1.0 e-05 corresponds to a 1 in 100,000 chance, 1.0 e-04, 1 in 10,000, and so on. U.S. EPA may perform a Remedial Action if cancer risks are greater than 1.0 e-04, or a Hazard Index of 1.0 or greater.

3 Calculated in 1990 by computer models ("SeSOIL" and "AT123D") which simulated contaminant release as leachate from soil and sludge.

4 Taken from February 1990 Remedial Investigation (RI) Report, Chapter 6. Original risk calculations based on limited availability of carcinogenic potency information, and computer models noted in Footnote (3). A fundamental requirement for this remedy is a lagoon area cover that must prevent all unacceptable contact with contaminated sludge and/or soil.

5 Calculated in 1990 by a computer model ("ISCLT"), that assumed "worst-case" volatilization of organics from lagoon area sludge.

6 Surface water risks calculated in 1990 by a computer model ("EXAMS-II") that simulated the fate of contaminants in groundwater discharging to a surface water body. State of Michigan Groundwater-Surface Water Interface (GSI) Standards will be the performance criteria for this remedy and will insure protection of Big Black Creek. In addition, the continuation of adequate capture of contaminated groundwater before discharge to the Creek (which has been in operation since the mid-1970s) is a fundamental requirement for this remedy, and thus the surface water exposure pathway will continue to be eliminated.

## TABLE 5 - CAPITAL COSTS REQUIRED FOR TIC REMEDY [1]

| PROJECT ACTIVITY | QUANTITY | UNIT COST | COST |
|---|---|---|---|
| Lagoon Area surface cleanup and earthwork [2] | 15 acres * | $ 16,118 / acre | $ 241,770 |
| Lagoon Area Cap construction (including seeding, mulching, etc.) [3] | 15 acres * | $ 33,306 / acre | $ 499,590 |
| Planting of vegetation (Areas A,B,C,D, including fertilizer) [4] | 17 acres * | $ 68,000 / acre | $ 1,156,000 |
| Monitoring (start-up) of installed vegetation (1st 5 years) including replacement (if needed) | 20 acres * | $ 26,750 / acre | $ 535,000 |
| Barrier Wall installation [5] | 2700 feet | $ 1,175 / foot | $ 3,172,500 |
| Groundwater Extraction System [6] | Lump Sum | | $ 798,480 |
| Constructed Wetland [7] | Lump Sum | | $ 508,650 |
| Retrofit existing GWTP for TIC Remedy [8] | Lump Sum | | $ 395,000 |
| Replacement GWTP (after 5 years) [9] | Lump Sum | | $ 675,000 |
| Installation of Monitoring Wells [10] | 30 wells | $ 5,667 each | $ 170,000 |
| SUBTOTAL | | | $ 8,151,990 |
| Cost Estimate Contingency (25 %) | | | $ 2,038,000 |
| MINIMUM CONSTRUCTION CAPITAL FUNDING | | | $10,189,990 |
| Contingent Action - Upgrade of cap impermeability [11] | 15 acres | $ 94,600 / acre | $ 1,419,000 |
| Contingent Action - Maint. and/or Repair of Const. Wetland [12] | Lump Sum | | $ 793,770 |
| Contingent Action - Restore/enhance installed vegetation [13] | Lump Sum | | $ 621,840 |
| Contingent Action - Additional Barrier Wall (including design) | Lump Sum | | $ 723,520 |
| Contingent Action - Install 10 New Extraction Wells in addition to Barrier Wall | 10 wells<br>500 ft. piping | $10,000 each<br>$ 35/ft pipe | $ 117,500 |
| SUBTOTAL OF CONTINGENT ACTIONS | | | $ 3,675,630 |
| Cost Estimate Contingency (25 %) | | | $ 918,910 |
| ADDITIONAL CONSTRUCTION CAPITAL FUNDING REQUIRED FOR CONTINGENT ACTIONS | | | $ 4,594,540 |
| TOTAL CONSTRUCTION CAPITAL INCLUDING CONTINGENT ACTIONS | | | $ 14,784,530 |
| REMEDIAL DESIGN (RD) COST FOR TIC REMEDY [14] | | | $ 5,450,000 |
| MINIMUM CONSTRUCTION CAPITAL | | | $ 10,189,990 |
| TOTAL MINIMUM PROJECT COST | | | $ 15,639,990 |

**FOOTNOTES FOR TABLE 5**

* Actual lagoon and sludge surficial area totals approximately 15 acres (see Figure 3). A value of 17 acres is estimated for planted vegetation to include 2 additional acres for integration of vegetation into natural vegetation existing at the lagoon periphery. An allowance of 20 acres is used for monitoring and includes 5 acres as contingency.

1 All values shown are approximate and are included for ROD Amendment purposes. Cost estimates have been provided in the document entitled "Technical Memorandum, Total In-Situ Containment Conceptual Design - Bofors-Nobel Superfund Site" dated September 9, 1997, (the "Tech Memo") available for review in the Administrative Record. These cost estimates will be further refined during the RD.

2 Table 8-4 of 9/9/97 Tech Memo - Items 1 through 9.

3 Table 8-4 of 9/9/97 Tech Memo - Items 10 through 17, including an allowance for field work completion document.

4 Table 8-5 of 9/9/97 Tech Memo - Items 1 through 12, including dust control during construction. Areas A, B, C, and D are designations that represent different vegetative species, with Area A containing the highest concentrations of contaminants.

5 Table 8-6 of 9/9/97 Tech Memo - Items 1 through 14.

6 Table 8-8 of 9/9/97 Tech Memo - Items 1 - 13. This task entails retrofit of existing extraction well system and construction of collection, extraction, discharge point in concert with barrier wall (such as control weir and/or valving).

7 Table 8-7 of 9/9/97 Tech Memo - Items 1 through 17.

8 Table 8-9 of 9/9/97 Tech Memo - Items 1 and 2. This task entails consideration of using a portion of the already operating U.S. EPA GWTP and/or retrofit, if feasible.

9 Table 8-11 B of 9/9/97 Tech Memo. This is the possible GWTP replacement with a smaller, alternative GWTP and lower extraction rates created by the barrier wall. Cost shown is discounted value to Year 2002.

10 Table 8-10 - Item 1, and Table 8-11A - Items 1 through 3 of 9/9/97 Tech Memo. Capital allowance represents a one-time monitoring well installation capital cost for both measurement of barrier wall effectiveness and potential natural attenuation. Short- and Long-Term Monitoring costs are included in Table 6, which summarizes annual costs for operation and maintenance and monitoring.

11 Table 8-4 of 9/9/97 Tech Memo.

12 Table 8-7 of 9/9/97 Tech Memo.

13 Table 8-5 of 9/9/97 Tech Memo. Nutrients, installation of 'tube' protection through highest contamination layer, and supplemental Zone A re-planting included in this contingent task.

14 Tables 8-10 and 8-13 of 9/9/97 Tech Memo. Includes all costs for RD sampling and analysis activity including all quality assurance and work plans.

## TABLE 6 - PRESENT WORTH OF O&M AND MONITORING COSTS[1] FOR TIC REMEDY

| ITEM | PROJECT ACTIVITY | ANNUAL COST[2] | PROJECT YEAR FROM - TO | YEARS AWAY FROM 1999 | P/F FACTOR[3] (@ 5%) | ANNUAL COST DISCOUNTED TO YEAR 1999 | TIME PERIOD IN YEARS | P/A FACTOR[3] (@ 5%) | PRESENT WORTH IN 1999 DOLLARS[4] |
|---|---|---|---|---|---|---|---|---|---|
| a. | Groundwater Monitoring During RD/RA Activity (1st 2 years, quarterly) [5] | $ 80,000 | 1999 - 2002 | 0 | 1.0 | $ 80,000 | 3 | 2.722 | $ 217,760 |
| b. | Post-construction Groundwater Monitoring [6] | $ 70,000 | 2002 - 2007 | 3 | 0.864 | $ 60,480 | 5 | 4.331 | $ 261,940 |
| c. | Long Term Groundwater Monitoring | $ 70,000 | 2007 - 2032 | 8 | 0.677 | $ 47,390 | 25 | 14.096 | $ 668,010 |
| d. | Long Term Groundwater Monitoring [7] | $ 50,000 | 2032 - 2102 | 33 | 0.200 | $ 10,000 | 70 | 19.343 | $ 193,430 |
| e. | Operation of Existing GWTP [8] | $ 600,000 | 1999 - 2002 | 0 | 1.0 | $ 600,000 | 3 | 2.722 | $ 1,633,200 |
| f. | Operation of Existing Extraction Well Field [9] | $ 150,000 | 1999 - 2002 | 0 | 1.0 | $ 150,000 | 3 | 2.722 | $ 408,300 |
| g. | Operation of Existing GWTP [10] | $ 400,000 | 2002 - 2007 | 3 | 0.864 | $ 345,600 | 5 | 4.331 | $ 1,496,800 |
| h. | Operation of Existing Extraction Well Field [11] | $ 100,000 | 2002 - 2007 | 3 | 0.864 | $ 86,400 | 5 | 4.331 | $ 374,200 |
| i. | Initial Lagoon and GWTP Site Management [12] | $ 200,000 | 2002 - 2007 | 3 | 0.864 | $ 172,800 | 5 | 4.331 | $ 748,400 |
| j. | O&M of New Alternative GWTP [13] | $ 400,000 | 2007 - 2032 | 8 | 0.677 | $ 270,800 | 25 | 14.096 | $ 3,817,200 |
| k. | Post-construction Lagoon Area Site Management [14] | $ 100,000 | 2007 - 2032 | 8 | 0.677 | $ 67,700 | 25 | 14.096 | $ 954,300 |
| l. | O&M of New Alternative GWTP (includes sampling and analysis needed for GWTP operation) | $ 253,000 | 2032 - 2102 | 33 | 0.200 | $ 50,600 | 70 | 19.343 | $ 978,760 |
| m. | Long Term Lagoon Area Site Management [15] | $ 50,000 | 2032 - 2102 | 33 | 0.200 | $ 10,000 | 70 | 19.343 | $ 193,430 |
| | SUBTOTAL | | | | | | | | $11,945,730 |
| n. | Cost Estimate Contingency (25 %) | | | | | | | | $ 2,986,430 |
| o. | TOTAL PRESENT WORTH OF ANNUAL COSTS | | | | | | | | $14,932,160 |

**FOOTNOTES FOR TABLE 6**

1 All values shown are approximate and are included for ROD purposes. Cost estimates have been provided in the document entitled "Technical Memorandum, Total In-Situ Containment Conceptual Design - Bofors-Nobel Superfund Site" dated September 9, 1997, (the "Tech Memo") available for review in the Administrative Record. These cost estimates will be further refined during the Remedial Design.

2 Annual cost value shown is discounted to first year of "From - To" time period (i.e., 'annual cost' value for Item b. is for Year 2002).

3 See Table 6A for explanation of P/A Factor and Present Worth, and Table 6B for P/F Factor.

4 Present Worth value reflects 1999 funding needed to cover annual cost shown.

5 Table 8-10 of 9/9/97 Tech Memo, Item #3. Costs of Quality Assurance and Work Plans are included in Remedial Design cost shown in previous Table 6. Costs of sampling activity which occurs during Remedial Design are included in Remedial Design costs.

6 Table 8-12 of 9/9/97 Tech Memo, Item called "Annual Monitoring".

7 Table 8-12 of 9/9/97 Tech Memo, Item called "Annual Monitoring for Permanent Operation".

8 Table 8-11 B of 9/9/97 Tech Memo, Item #1.

9 Table 8-11 B of 9/9/97 Tech Memo, Item #2.

10 Table 8-11 B of 9/9/97 Tech Memo, Item #4.

11 Table 8-11 B of 9/9/97 Tech Memo, Item #5.

12 Table 8-11 B of 9/9/97 Tech Memo, Item #3. Site Management costs includes general administration, management, inspection of lagoon area (TIC Remedy), and reporting requirements for the Site.

13 Table 8-12 of 9/9/97 Tech Memo, sum of "New Plant Long Term Maintenance and New Plant Operation". If no GWTP alternative exists or is not available, then contingency may include continued operation of existing U.S. EPA GWTP, at a level corresponding to the volumetric fraction of extracted TIC groundwater treated. Annual costs shown reflects technical operation activity, including GWTP repair and preventive maintenance.

14 Table 8-12 of 9/9/97 Tech Memo, Item entitled "Site Management", Years 2007 to 2031. Site Management costs includes general administration, management, and inspection of lagoon area (TIC Remedy) and reporting requirements for the Site.

15 Table 8-12 of 9/9/97 Tech Memo, Item entitled "Site management", Years 2032 to 2101.

## TABLE 6A - Present Worth Formula

Because different remedial alternatives have different operating costs and time periods, it is necessary to provide some equivalent value between alternatives for comparison purposes. The present worth of an alternative is a measure of how much money will have to be put aside now to provide for one or more future expenditures. To find the present worth of a series of cash disbursements (such as annual O&M), it is necessary to discount future amounts to the present by using an interest rate (for the appropriate number of years) in the following manner:

(1) Present Worth = $F_0(1 + i)^0 + F_1(1 + i)^{-1} + \ldots$

$$+ F_k(1 + i)^{-k} + \ldots + F_n(1 + i)^{-n}$$

where $F_k$ = future cash flow at end of period k
i = interest rate
k = index for each compounding period ($0 \leq k \leq n$)
n = number of years
A = annual cost (O&M cost)

This series is summarized by the following equations:

(2) Total P.W. = Capital Cost + Present Worth of Annual Cost

(3) P.W. of Annual Cost = Annual Cost x P/A Factor

(4) $$\frac{P}{A} = \frac{(1 + i)^n - 1}{i(1 + i)^n}$$

Thus, for Item b. of Table 6 ($ 70,000, or $ 60,480 in 1999 dollars for 5 yrs. @ 5%):

$$\frac{P}{A} = \frac{(1 + i)^n - 1}{i(1 + i)^n} = \frac{(1 + 0.05)^5 - 1}{0.05*(1 + 0.05)^5} = 4.331$$

and

P.W. of Monitoring = $ 60,480 x 4.331 = $ 261,940

Source: Engineering Economy, 7th ed., DeGarmo, Sullivan, Canada, Macmillan Publishing, 1984.

## TABLE 6B - Discount of Future Costs to Present Value Formula

A present worth analysis was performed to provide a current equivalent value for project tasks over the entire project life for comparison purposes. Annual cost at some future time must be adjusted to reflect dollar values at the present moment. The present worth of a future cost is a measure of the equivalent current value of money used at a later date. To find the present worth of a future cost (such as an O&M cost 33 years from now), it is necessary to discount future amounts to the present, in a manner very similar to the Present Worth formula explained in Table 6A.

(1) P.W. of Future Cost = Future Cost x P/F Factor

(2) $$\frac{P}{F} = \frac{1}{(1+i)^n}$$

Thus, for item b. of Table 6 ($ 70,000 at Project Year 2002 (or n=3) @ 5%):

$$\frac{P}{F} = \frac{1}{(1+i)^n} = \frac{1}{(1+0.05)^3} = 0.8638$$

and

P.W. of Future Annual Cost of Monitoring = $ 70,000 x 0.864 = $ 60,480

Source: Engineering Economy, 7th ed., DeGarmo, Sullivan, Canada, Macmillan Publishing, 1984.

**TABLE 7 - "TIME WEIGHTED" AVERAGE ANNUAL COST OF MONITORING & O&M OF TIC REMEDY**

| ITEM | PROJECT ACTIVITY[1] | ANNUAL COST[2] | YEARS FROM - TO | TIME PERIOD (YRS.) | FRACTION OF PROJECT TIME | "WEIGHTED" ANNUAL COST |
|---|---|---|---|---|---|---|
| a. | GW Monitoring During RD/RA | $ 80,000 | 1999 - 2002 | 3 | 3÷103 = 0.029 | $ 2,320 |
| b. | Post-const. GW Mon | $ 70,000 | 2002 - 2007 | 5 | 5÷103 = 0.049 | $ 3,430 |
| c. | LTGW Monitoring | $ 70,000 | 2007 - 2032 | 25 | 25÷103 = 0.243 | $ 17,010 |
| d | LTGW Monitoring | $ 50,000 | 2032 - 2102 | 70 | 70÷103 = 0.680 | $ 34,000 |
| TOTAL TIME | | | 103 | "TIME WEIGHTED" ANNUAL COST OF MONITORING[3] | | $ 56,760 |
| e. | Existing GWTP Oper. | $ 600,000 | 1999 - 2002 | 3 | 0.029 | $ 17,400 |
| f. | Existing Well Oper. | $ 150,000 | 1999 - 2002 | 3 | 0.029 | $ 4,350 |
| g. | Existing GWTP Oper. | $ 400,000 | 2002 - 2007 | 5 | 0.049 | $ 19,600 |
| h. | Existing Well Oper. | $ 100,000 | 2002 - 2007 | 5 | 0.049 | $ 4,900 |
| I. | Initial Site Mgmt. | $ 200,000 | 2002 - 2007 | 5 | 0.049 | $ 9,800 |
| j. | O&M of New Alt. GWTP | $ 400,000 | 2007 - 2032 | 25 | 0.243 | $ 97,200 |
| k. | Post-const. Site Mgmt. | $ 100,000 | 2007 - 2032 | 25 | 0.243 | $ 24,300 |
| l | O&M of New Alt. GWTP (inc. Samp./Analysis) | $ 253,000 | 2032 - 2102 | 70 | 0.680 | $ 172,040 |
| m. | Long Term Site Mgmt . | $ 50,000 | 2032 - 2102 | 70 | 0.680 | $ 34,000 |
| "TIME WEIGHTED" ANNUAL O&M COST[3] | | | | | | $ 383,590 |

**FOOTNOTES FOR TABLE 7**

1,2 As identified in Table 6. All values shown are approximate and are included for ROD purposes. Cost estimates have been provided in the document entitled "Technical Memorandum, Total In-Situ Containment Conceptual Design - Bofors-Nobel Superfund Site", dated September 9, 1997, (the "Tech Memo") available for review in the Administrative Record. These cost estimates will be further refined within the Remedial Design.

3 "Time weighted" annual costs do not represent higher O&M costs during initial remedy operation because of the variance in annual O&M costs and time periods. A decrease in the total project time period will increase the "time weighted" values shown.

**DECLARATION FOR THE SECOND AMENDMENT TO THE RECORD OF DECISION BOFORS-NOBEL OPERABLE UNIT #1 - LAGOON AREA**

**APPENDIX A - Discussion of Applicable or Relevant and Appropriate Requirements (ARARs)**

The 1990 ROD, 1992 ROD Amendment, and July 16, 1996 remedy re-evaluation established Applicable or Relevant and Appropriate Requirements (ARARs) for this site. U.S. EPA has reviewed these ARARs in light of the TIC remedy alternative and has determined that the substantive provisions of the following continue to be ARARs or potential ARARs for this operable unit:

**I. FEDERAL**

**I.A. Federal - Action Specific:** Action-specific ARARs are requirements that define acceptable treatment and disposal procedures for hazardous substances.

I.A.1. Clean Water Act, as amended [33 U.S.C. § 1251]:

The National Pollutant Discharge Elimination System (NPDES) specifies the substantive requirements for discharges into surface waters, including effluent standards and limitations. 40 CFR 122, 125 and 136 establish guidelines and procedures for the National Pollutant Discharge Elimination System (NPDES). The NPDES program is administered by MDEQ under Michigan Public Act 245, Part 21.

These substantive requirements are applicable to the TIC remedy because extraction, treatment, and discharge of groundwater on-site to Big Black Creek is a remedy component. Because the Groundwater Treatment Plant (GWTP) constructed by U.S. EPA has been designed to satisfy (and has been satisfying) such discharge requirements identified by MDEQ, continued use of the GWTP complies with this ARAR. Any groundwater treatment system that is implemented as an alternative to the GWTP and all other relevant components of the TIC remedy will also be designed and constructed according to such MDEQ surface water discharge requirements to insure compliance with this ARAR. These discharge standards will first be developed during the Remedial Design and may be refined as construction and operation of the TIC remedy proceeds. Use of a natural (vegetative) treatment cell for containment and treatment of groundwater (which may not include a specific effluent pipe line or "point source" discharge) will also be subject to surface water discharge requirements established by MDEQ. Until new site specific

surface water standards are developed (if necessary), site standards already in place will be complied with at all times, including design, construction, and start-up of the TIC remedy.

I.A.2. Clean Air Act, as amended [42 U.S.C. § 7401]:

The Clean Air Act was enacted to protect and enhance air quality. 40 CFR 6 provides that all Federal projects, licenses, permits, plans, and financial assistance activities conform to any State Air Quality Implementation Plan (SIP). 40 CFR Part 50 establishes primary and secondary ambient air quality standards that are applicable to emissions generated either during construction activities or during operation of any groundwater treatment facility, including the GWTP constructed by U.S. EPA. The TIC remedy will comply with this ARAR during design, construction, and operation.

**I.B. Federal - Location Specific:** Location-specific ARARs are those requirements that relate to the geographical position of a site.

I.B.1. Section 10 of the Federal River and Harbor Act, as amended:

This Act regulates obstruction or alteration of any navigable water in the United States, including connected wetlands. These requirements are implemented through 33 CFR Parts 320-330. Because construction activities for the TIC remedy pose a potential impact on Big Black Creek and/or connected wetlands, this statute is an ARAR. The TIC remedy will comply with this ARAR during design, construction, and operation, and will provide for any necessary mitigative measures.

I.B.2. Clean Water Act (CWA) of 1977, as amended, [33 U.S.C. 1344], 33 CFR 322:

Section 404 of the Clean Water Act also specifically establishes limitations on the discharge of dredged or fill material into surface waters, including adjacent wetlands. The TIC remedy will comply with the substantive requirements of this ARAR by subjecting construction documentation to review by appropriate authority.

I.B.3. Executive Orders 11988 40 CFR 6:

Executive Orders 11988 40 CFR 6 similarly requires that construction activities avoid long- and short-term adverse impacts associated with actions in the wetland or floodplain areas. The TIC remedy will comply with this ARAR during construction activities.

**I.C. Federal - Chemical Specific:** Chemical-specific ARARs regulate the release to the environment of specific substances having certain chemical characteristics, and typically determine the extent of clean-up at a site.

I.C.1. Clean Water Act [33 U.S.C. 1251], Toxic Pollutant Effluent Standards [40 CFR 129]:

Title 40, Part 129 of the Code of Federal Regulations establishes toxic pollutant effluent standards and prohibitions of specific compounds for specified facilities discharging into navigable waters. 40 CFR 129.104 sets the ambient water criterion for Benzidine in navigable water as 0.1 ug/l. This standard is an ARAR for discharges from whatever groundwater treatment facility that will be used for the TIC remedy. As noted previously, the GWTP has been designed to satisfy, and has been satisfying, these requirements, and thus its use complies with this ARAR. Implementation of any alternative to the GWTP and other relevant portions of the TIC remedy will be designed, constructed, and operated to comply with this ARAR.

I.C.2. Resource Conservation and Recovery Act (RCRA), Subtitle C (42 U.S.C. § 6901):

Wastes that were deposited in the lagoons are by-products of specialty chemical production that occurred on site before the enactment of RCRA. U.S. EPA determined that RCRA and State landfill cap standards were relevant and appropriate requirements for the Landfill Remedy. Because the TIC remedy has different objectives, including movement and capture of groundwater within the source area and reduction of contamination by the treatment components provided by the remedy, RCRA and State landfill cap standards are not ARARs for the lagoon area cover portion of the TIC remedy. Because the O.U. #1 lagoon area cover must be permeable for sustaining the vegetative components of the TIC remedy, the O.U. #1 lagoon area cover currently proposed will not meet RCRA cap requirements. In the event a TIC cover upgrade is later required as a Contingent Remedial Action, substantive

portions of RCRA and Part 111 of NREPA which deal with the design and construction of hazardous waste covers may be ARARs for that upgrade. RCRA and Part 111 of NREPA standards would be ARARs for any excavation activity. In the event that surface cleanup phase of the remedy requires some excavation and off-site disposal, the excavated material shall be characterized, manifested, and disposed of in accordance with these RCRA and parallel State requirements.

In addition, to the extent groundwater treatment residuals exhibit hazardous characteristics, on-site activities relating to disposal of those residuals will comply with the applicable provisions of 40 CFR Parts 264 and 268. However, sludge generated within the operating groundwater treatment system does not exhibit any RCRA characteristics and is disposed of in a sanitary waste landfill. Further, technical requirements for long-term monitoring systems may be relevant and appropriate for groundwater monitoring programs required for the TIC remedy.

I.C.3. Safe Drinking Water Act (SDWA) of 1974 (42 U.S.C. 300(f)), as amended:

The Safe Drinking Water Act was enacted to assure high quality drinking water in public water supplies. Specifically, 40 CFR 141 specifies maximum chemical contaminant levels (MCLs) for inorganic and organic chemicals, maximum contaminant level goals (MCLGs) for organic chemicals, and establishes national revised primary drinking water regulations of MCLs for organic chemicals. Surface water in Big Black Creek and groundwater in the site vicinity are not currently distributed through the public water supply systems. Therefore, these regulations are not applicable to the site. These standards are, however, relevant and appropriate to establishing final groundwater cleanup standards that could allow for discontinuing the groundwater containment portion of the remedy.

As noted above, the groundwater treatment facility currently satisfies all discharge limitations to Big Black Creek.

## II. STATE

### II.A. State - Action Specific

II.A.1. Part 31 of the Natural Resources and Environmental Protection Act 1994 PA 451, as amended, (formerly Act 245 of the Public Acts of 1929, as amended: Water Resources Commission Act:

The National Pollutant Discharge Elimination System (NPDES) is implemented by the MDEQ, which administers and specifies the substantive requirements for discharges into surface waters, including effluent standards and limitations under Part 21 of the Administrative Rules. Part 4 of the Administrative Rules, Rule 57 also establishes water quality standards for all waters of the state. Those requirements establish limits for discharge of dissolved solids, pH, taste and odor producing substances, toxic substances, nutrients and dissolved oxygen.

These substantive requirements are applicable to the TIC remedy as it includes extraction, treatment, and discharge of groundwater on-site to Big Black Creek. The groundwater treatment facility has been designed to satisfy, and has been satisfying, the surface water discharge requirements identified by MDEQ. Any groundwater treatment system that is implemented as an alternative to the GWTP and all other relevant components of the TIC remedy will also be designed and constructed according to such MDEQ surface water discharge requirements to insure compliance with this ARAR.

II.A.2. Part 55 of the Natural Resources and Environmental Protection Act 1994 PA 451, as amended, (formerly Act 348 of the Public Acts of 1965, as amended, Air Pollution Act: Part 3):

This law establishes standards for the density of emissions and emission of particulate matter. The TIC remedy will require some degree of excavation, resulting in agitation of site soils and sludges. The TIC remedy will likely require some degree of emissions control during construction. These requirements will likely be minimal because the TIC remedy involves limited excavation and materials handling.

For dust control, the most effective method is wet suppression using water alone, or a chemical suppressant in water. This will capture sludge and soil particles, and will inhibit migration of volatile and semi-volatile vapor. At the end of each daily construction period, excavation and stockpile areas will be covered appropriately to prevent

releases during off-hours. In the event wet suppression alone does not adequately control site emissions to within required levels, it will be possible to perform further controls as discussed above, including erection of wind screens. It is expected that by using these measures, the TIC remedy will comply with the substantive requirements of this ARAR.

**II.B. State - Location Specific:**

II.B.1. Part 303 of the Natural Resources and Environmental Protection Act 1994 PA 451, as amended, (formerly Act 203 of the Public Acts of 1979, The Goemaere-Anderson Wetland Protection Act):

These rules apply to activities that result in discharge to the wetland area that drains to the Big Black Creek. These rules include permitting requirements, wetland determination, and mitigation. It is expected that the TIC remedy would include all necessary procedures needed to comply with this statute.

II.B.2. Part 91 of the Natural Resources and Environmental Protection Act 1994 PA 451, as amended, (formerly Act 347 of the Public Acts of 1972, Soil Erosion and Sedimentation Control Act):

Part 17 of the Administrative Rules, Soil Erosion and Sedimentation Control, establishes general soil erosion and sedimentation control procedures and measures, as well as earth change requirements and soil conservation district standards and specifications. The TIC remedy will result in agitation of one or more acres of land within 500 feet of a stream. Therefore, these are relevant and appropriate, and it is expected that the TIC remedy evaluated here will comply with this statute.

**II.C. State - Chemical Specific:**

II.C.1. Part 31 of the Natural Resources and Environmental Protection Act 1994 PA 451, as amended, (formerly Act 245 of the Public Acts of 1929, as amended, Water Resources Commission Act), Administrative Rules Part 4, Rule 323.1057 (Rule 57), Water Quality Standards (Surface Water Quality Standards):

Part 31 of NREPA, Part 4, Rule 57 establishes limits for all waters of the State. Standards for toxic substances are established on a site-specific basis. As noted above, the groundwater treatment facility recently constructed is

currently required to, and does, satisfy discharge limitations to Big Black Creek. The TIC remedy will therefore comply with this ARAR.

II.C.2. Part 55 of the Natural Resources and Environmental Protection Act 1994 PA 451, as amended, (formerly Act 348 of the Public Acts of 1965, as amended, Air Pollution Act): Administrative Rules Parts 7 and 9:

This establishes standards for the emission of regulated contaminants into the air. The TIC remedy evaluated here will require some degree of excavation, resulting in agitation of site soils and sludges, which will result in emissions. Although the TIC remedy should stir up less airborne material than the Landfill Remedy originally selected, some degree of emissions control during construction may be needed. This is applicable to the overall site air quality and does not account for air releases created by nearby industrial facilities.

For dust control, the most effective method is wet suppression using water alone, or a chemical suppressant in water. This will capture sludge and soil particles, and will inhibit migration of volatile and semi-volatile vapor. At the end of each daily construction period, excavation and stockpile areas will be covered appropriately to prevent releases during off-hours. In the event wet suppression alone does not adequately control site emissions to within required levels, it will be possible to perform further controls as discussed above, including erection of wind screens.

Rule 901 of Part 55 requires that no emissions of an air contaminant can occur in quantities that cause injurious effects to human health or safety. Specifically, the contaminant concentration that corresponds to a $10^{-6}$ 70 year lifetime cancer risk can not be exceeded at the site boundary.

The TIC remedy may require excavation, grading, and/or stabilization of soft areas of the lagoon area. Also, soil/slurry mixing processes will be implemented, indicating that real time perimeter site monitoring and dust control will be needed. It is expected that the earth work involved with the TIC remedy will not be as extensive as the Landfill Remedy originally selected, and should remain within acceptable Part 55 levels with the use of emissions control.

II.C.3. Part 201 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (formerly known as Act 307 of the Michigan Environmental Response Act):

In the 1992 ROD Amendment, the substantive provisions of Parts 6 and 7 of the rules promulgated under Part 201 were identified as an ARAR for the Landfill Remedy to be undertaken at this site. These rules provided, inter alia, that remedial action be protective of human health, safety and the environment by a degree of cleanup conforming to one or more of three cleanup types; Type A, B, and C. The ROD and the amended ROD determined that the selected soil remedy would satisfy Act 307 soil cleanup standards. The Act 307 standards have since been replaced by new standards under Part 201.

The amended Part 201 now defines cleanup standards according to categorical criteria that define the nature of site for which Remedial Action is necessary. Specific cleanup categories are: residential, commercial, recreational, industrial, limited residential, limited commercial, limited recreational, limited industrial, and other land use based on limited categories as established by MDEQ. Part 201 groundwater cleanup criteria are considered ARARs. Under the TIC remedy, the barrier wall is required to immediately contain all areas in excess of Part 201 soil cleanup criteria, and ultimately achieve these criteria with the treatment provided by the remedy. Further, meeting the performance standards required of the TIC remedy insures that groundwater outside the contained area will not exceed Part 201 cleanup standards, including compliance with Section 20120a(15) requiring that groundwater venting to surface water meet the NREPA Part 31 standards. Under Rule 705(5) of Part 201 (Environmental Remediation), groundwater contamination may not be permitted to migrate laterally beyond its present boundaries. The ultimate goal of the remedy is to further achieve compliance with Part 201 soil and groundwater standards within the barrier wall as well. The containment portions of the remedy will continue unless and until these standards are met throughout the affected areas.

It is anticipated that implementation of the TIC remedy will limit development of site property in order to assure the continued integrity of the O.U. #1 lagoon area cover. Areas immediately adjacent to the site are primarily industrial, and implementation of the TIC remedy precludes or significantly limits future development for the site. Thus,

Part 201 cleanup criteria for future industrial land use are applicable unless appropriate deed restrictions can not be obtained, in which case criteria for future residential land use would apply and would be the relevant ARAR.

II.C.4. Part 111 of the Natural Resources and Environmental Protection Act 1994 PA 451, as amended, (formerly Michigan Hazardous Waste Management Act, PA 64):

U.S. EPA determined that both RCRA and State landfill cap standards were relevant and appropriate requirements for the Landfill Remedy. Because the TIC remedy has different objectives, including movement and capture of groundwater within the source area and reduction of contamination by treatment, Part 111 landfill cap standards are not ARARs for the TIC remedy. Substantive portions of Part 111 which deal with the design and construction of hazardous waste covers may be ARARs if a specific Contingent Remedial Action dealing with protective covers is implemented. Part 111 would be ARARs for any excavation activity. In the event that surface cleanup phase of the remedy requires some excavation and off-site disposal, the excavated material shall be characterized, manifested, and disposed of in accordance with these State requirements.

In addition, to the extent groundwater treatment residuals exhibit hazardous characteristics, on-site activities relating to disposal of those residuals will comply with the applicable provisions of Part 111 regulations implementing the federal RCRA requirements described above.

## DECLARATION FOR THE SECOND AMENDMENT TO THE RECORD OF DECISION BOFORS-NOBEL OPERABLE UNIT #1 - LAGOON AREA APPENDIX B - Responsiveness Summary

This Responsiveness Summary has been prepared to provide answers to public concerns regarding the cleanup plan for the O.U. #1 lagoon area soil, sludge, and groundwater. This Responsiveness Summary also meets the requirements of Sections 113(k)(2)(B)(iv) and 117(b) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (CERCLA), which requires the United States Environmental Protection Agency (U.S. EPA) to respond to comments received on a proposed plan for remedial action. A notice of availability of the administrative record and proposed plan was published in the Muskegon Chronicle on June 15, 1998. This Responsiveness Summary addresses concerns expressed during the subsequent public comment period of June 15 through July 17, 1998. In addition, a public meeting to discuss the proposed plan was held on June 24, 1998 at the Egelston Township Hall and comments recorded at the meeting are addressed in this Responsiveness Summary. Some of the comments appearing below have been paraphrased for brevity. The Administrative Record contains copies of written comments and the transcript from the June 24th public meeting.

**COMMENT:**

What are the materials of construction for the O.U. #1 lagoon area cap portion of the Total In-situ Containment (TIC) remedy?

**U.S. EPA'S RESPONSE:**

Many of the specific construction details for the revised remedy will be defined during the Remedial Design process. U.S. EPA expects the O.U. #1 lagoon area cap to consist of soil, clay, and possibly synthetic liners (such as polyethylene) of a thickness and density to insure that there will be no unacceptable exposure to any contamination underneath.

**COMMENT:**

Are the trees and other vegetation intended to address soil contamination or groundwater contamination?

**U.S. EPA'S RESPONSE:**

The answer is "both". Trees and other vegetation will be installed inside the containment system provided by the cap,

barrier wall, groundwater extraction, and will help contain contaminated groundwater by natural uptake of water. Vegetation will also help in containing contaminated soils by having roots in the soil, keeping the soil in place. U.S. EPA expects the vegetation to provide additional benefits by enhancing the activity of existing "contaminant consuming" bacteria underground, or by synthesizing the contaminant compounds through their own internal processes. Even without those additional benefits, the TIC remedy fully addresses soil and groundwater contamination.

**COMMENT:**

How much water will be in the area contained by the TIC remedy with vegetation present? Will it resemble a swamp? What will happen to any water that accumulates in this area?

**U.S. EPA'S RESPONSE:**

U.S. EPA anticipates that, after construction of the TIC remedy is completed and all vegetative components have matured, there should not be any excessive accumulation of surface water in the contained area and this portion of the site will resemble the ecosystem currently surrounding the lagoons and at Big Black Creek. The barrier wall will be designed and constructed such that groundwater will be directed toward a central collection point, making it possible to control and limit any exposure to water within the containment area. During design and construction of the TIC remedy, some or all of the existing groundwater capture (extraction) system will continue to function. As an extra safeguard to containment provided by the TIC remedy, this existing system may be upgraded or replaced as needed. At the start of construction, there is a possibility that there may be some accumulation of water on the surface, before all the vegetation is installed and before it matures. Access to the contained areas, however, will be controlled with security measures and the contained area will be monitored to make sure there is no adverse impact on the Big Black Creek system.

**COMMENT:**

Will trees be able to grow in the O.U. #1 lagoon area environment? Is the TIC remedy somewhat experimental in nature?

**U.S. EPA's RESPONSE:**

The baseline components of the TIC remedy that will provide

immediate containment rely on common technology; barrier walls, soil and/or synthetic covers, and groundwater extraction. There are several other projects throughout the United States that use phytoremediation, and laboratory research has shown that it is possible to grow trees in an environment that contains contamination. The Administrative Record for this site contains information summarizing some of these laboratory results. The phytoremediation part of the TIC remedy is experimental in that there have not been many Superfund sites that have used vegetation on the relatively large scale that the TIC remedy will attempt.

**COMMENT:**

Although U.S. EPA anticipates using steel sheet piling for the barrier wall construction, how will is be possible to get clay down to the 75 to 100 foot depth without the excavation collapsing?

**U.S. EPA's RESPONSE:**

U.S. EPA anticipates that the use of sheet piling should stabilize any excavation wherever clay is used for the barrier wall component of the TIC remedy. In addition, the density of the clay slurry mix that is used can be increased to provide a more stable foundation within excavated areas and prevent any collapse. Slurry walls have ben constructed to depths up to 100 feet at other sites throughout the United States.

**COMMENT:**

Will the design of the O.U. #1 lagoon area cover prevent only humans from coming into physical contact with contamination, or will it protect animal life? Is the O.U. #1 lagoon area cover intended to prevent wind erosion or wind induced contaminated dust clouds?

**U.S. EPA'S RESPONSE:**

The intent of the O.U. #1 lagoon area cover is to prevent both human and animal life from coming into contact with contamination. U.S. EPA anticipates that the O.U. #1 lagoon area cover design will be very similar to many such covers that have been installed throughout the United States, and which inherently prevent any wind disturbance of soil.

**COMMENT:**

Is the water treatment plant that U.S. EPA currently uses the same one that has been in existence since the 1980s? Why didn't U.S. EPA use that facility instead of constructing the new one? Does the possibility exist that a third treatment plant, in addition to the Lomac and U.S. EPA plants, will be constructed? What will happen if U.S. EPA's new treatment plant is no longer needed?

**U.S. EPA's RESPONSE:**

The treatment plant that has been in operation since the 1980s is owned and operated by Lomac, who uses it for treatment of their chemical production process water. Back during the design of the new groundwater treatment plant, U.S. EPA investigated the possibility of retrofitting and using the Lomac facility. U.S. EPA (in consultation with the State of Michigan) decided to design and construct a new facility that discharges clean water into Big Black Creek instead of using up the Muskegon County treatment plant's limited capacity. U.S. EPA did not want to add to the County plant's burden by using the Lomac facility which discharges treated water to the County. With the use of a barrier wall and vegetation, the TIC remedy may be able to reduce the flow of groundwater that has to be treated, after a number of years. This means that U.S. EPA's new plant may have extra capacity and it might be more cost effective to install a smaller, more economical water treatment system. It may then be possible to help Muskegon County by having U.S. EPA's plant treat some of the industrial water users (such as Lomac or Sun Chemical).

**COMMENT:**

What is a typical time frame for the vegetation to start being active? Will it take approximately 20 or 25 years to remove the necessary amount of groundwater?

**U.S. EPA'S RESPONSE:**

U.S. EPA anticipates that it will take approximately five years for installed vegetation to mature. To date, laboratory studies on the use of vegetation for remedies have been more concerned with establishing the feasibility of the concept rather than estimating the time period needed to achieve complete cleanup. All groundwater and soil containment mechanisms, however, will be operated for as long as necessary, to protect human health, the environment, and Big Black Creek. A long term cleanup time

estimate will be developed either as part of the Remedial Design or during the Remedial Action, when the vegetation's treatment effectiveness can be more accurately measured.

**COMMENT:**

Are there different types of plants that are going to be used based on different types of contamination? Is there any plan to fertilize the trees?

**U.S. EPA's RESPONSE:**

To date, there are two species of trees that have been identified in the preliminary TIC remedy proposal, poplar and red cedar. These species have been selected because of their durability and fast-growing nature, and not because of any particular contaminant. Specific analysis regarding the treatment effectiveness of these (or other) species will be performed in more detail (including possible lab scale testing) during the Remedial Design process. Documents that have been included in the Administrative Record for the site suggest that the current lack of growth in the sludge lagoons is not due to toxicity from contamination, but from the lack of nutrients necessary for plant growth. Investigation of other construction in the local area (such as roadways and buildings) shows that once native plant species are disturbed, natural re-growth does not occur easily. U.S. EPA anticipates that installed vegetation will likely require introduction of water and fertilizers to insure adequate growth.

**COMMENT:**

Are there going to be any extraction wells on the south of the proposed barrier wall? Is the current system keeping all contaminants out of the creek?

**U.S. EPA RESPONSE:**

Although such details will be determined in the Remedial Design, one of the fundamental components of the TIC remedy is the assurance of adequate containment of contaminated groundwater. The current TIC remedy proposal anticipates that the barrier wall, once constructed, should adequately re-direct groundwater flow such that extraction wells outside of the barrier wall perimeter will not be necessary. Regardless of this, extraction wells south of the barrier wall may need to be installed to ensure protection of Big Black Creek in the event that the barrier wall and groundwater containment and extraction portion

of the TIC remedy is not fully effective. The current groundwater extraction system consists of twelve extraction wells installed between the mid-1970s and the mid-1980s. This system has been operating at an extraction rate high enough to capture all groundwater before reaching the Creek (therefore also capturing all contamination).

**COMMENT:**

In the new remedy, groundwater will be present in a wetland type area according to environmental standards. Does that mean that the water currently being treated and discharged into the creek does not meet such standards? Is the current state of the lagoons like a swamp or pond, that is, filled with water?

**U.S. EPA RESPONSE:**

As previously noted, the existing groundwater extraction system captures all contaminated groundwater before it can reach the Creek. U.S. EPA's currently operating groundwater treatment plant was designed to meet strict State of Michigan environmental standards for Big Black Creek and is currently meeting and maintaining those standards. The lagoons still contain sludge and have the consistency of a sand dune. Due to the sandy nature of the soil in the area, there is no standing water in any lagoon.

**COMMENT:**

Are metals (inorganics) of any concern at the site, and how would they affect the vegetation?

**U.S. EPA RESPONSE:**

Although inorganic contaminants were found in site soil, sludge, and groundwater, they were not at high enough levels to be identified as a threat to human health and the environment. U.S. EPA's groundwater treatment plant, however, was designed for and is capable of extracting any inorganic contaminants from groundwater, but throughout its 4 years of operation has not extracted any significant amounts of inorganics. U.S. EPA anticipates that the vegetation installed for the TIC remedy will not be adversely affected by any inorganic contaminants, and will not contain (by natural uptake) inorganic contamination at levels that pose any risk.

**COMMENT:**

How will U.S. EPA evaluate the remediation process? How will the effectiveness of the TIC remedy be measured? How will the community know it is working?

**U.S. EPA's RESPONSE:**

A program of regular sampling and analysis of the site is a fundamental requirement of the TIC remedy. Although the details of these monitoring programs will be defined in the Remedial Design, U.S. EPA anticipates that sampling of groundwater on both the inside and the outside of the barrier wall will occur regularly, as well as some soil sampling and possibly ecological monitoring.

Continual groundwater sampling will be a necessity in order to insure that the TIC remedy remains protective. This data, possibly enhanced with soil information, would also be used to establish the effectiveness of the TIC remedy in reducing the toxicity of contamination, and ultimately would determine whether the site is clean. U.S. EPA will make sure that the community is provided with regular updates, through mailings, the local media, and the public meeting process.

**COMMENT:**

The community has not recently been informed as to all that has transpired at the site. There have not been enough updates and U.S. EPA should provide 6 month updates as the site remedy progresses. The community prefers action and is a bit frustrated at the inaction over the past few years. Why has it taken all this time to get to this point?

**U.S. EPA'S RESPONSE:**

U.S. EPA has not provided regular updates due to the extensive negotiation process associated with obtaining financial commitments for the TIC remedy. Because of the confidentiality required during the development of these legal agreements over the past year, U.S. EPA could not provide details. Most of the work that has been happening for this project has been discussion, re-evaluation, and refinement of the basic requirements required to make implementation of the TIC remedy practicable. There has not been much design or construction field work to present to the community. In addition, much of U.S. EPA's efforts on this site have been aimed at refining and optimizing operation and maintenance of the groundwater treatment

plant. U.S. EPA will be updating the community on a more regular and re-occurring basis.

**COMMENT:**

The new plan appears to have significantly more community acceptance than the previous landfill remedy selected. Some community members applaud U.S. EPA for attempting something innovative, considering that the TIC remedy seems the best possibility for natural treatment as opposed to an incineration or landfilling option. It is about time to treat the soils which seem to be continually contributing pollutants to groundwater.

**U.S. EPA'S RESPONSE:**

Although Superfund requirements dictate that treatment is always a preferred option, the first amendment to the O.U. #1 Record of Decision for this site removed incineration as an option and replaced it with an on-site landfill containment alternative. At the time of the first ROD Amendment, it was shown that conventional treatment technology for the excessive amount of contaminated site soil was not practicable. In U.S. EPA's re-evaluation document, the landfilling option was noted as the preferred method of containment (due to implementability), but that the TIC remedy could be refined and implemented to provide an equivalent level of containment. Now that U.S. EPA has the necessary commitments for such refinements and implementation, the TIC remedy can be implemented. The remedy also provides an added benefit of contaminant degradation through more natural means by the treatment provided by phytoremediation. The nature of the TIC remedy more readily accommodates further remedial action on some or all soil contamination if it becomes necessary. New remedy options will continue to be considered in the event the treatment provided by phytoremediation as not as effective as anticipated.

**COMMENT:**

How large of an area would the proposed deed restrictions cover? What is the nature of these restrictions?

**U.S. EPA'S RESPONSE:**

The deed restrictions mentioned in this ROD Amendment are intended to insure that no one uses contaminated site groundwater or site soil after remedial action starts. Also, any activity that might damage or otherwise impair the effectiveness of any part of the TIC remedy would be prohibited. A deed restriction

is a simple statement of a property's history, what has been done on or to the property, and what can or can not be done on or to the property after a remedy is started. Deed restrictions can only be implemented by a person who controls a property or a property owner, and usually comes into play when the property is bought, sold, or otherwise transferred. The deed restrictions will extend over the entire site.

**COMMENT:**

Has there been any testing done on resident's wells, and how far away from the site? What about soils at residences? U.S. EPA must insure that the aquifer underneath the site has not been reaching resident's homes. Why hasn't U.S. EPA conducted yearly sampling of well water? New residences along Wolf Lake Road will use well water as a water source. Are the Bofors site PRPs going to assist residents of Egelston and Sullivan Townships financially for Muskegon County water in the distant future?

**U.S. EPA'S RESPONSE:**

In the late 1980s, at the time of site characterization studies, wells and soil outside the site boundary to the north and east was sampled, and no unacceptable levels of site contaminants were discovered. To the south, wells and soil were sampled (in some places as far as 500 feet away) on the other side of Big Black Creek, and no unacceptable concentrations of site contaminants were found beyond the Creek. To the west of the site, there are no immediate residents because of the Sun and Lomac facilities. Between site characterization and the current TIC remedy proposal of September 1997, there has been extensive site sampling and analysis, creating a wealth of site data. It has been determined by both U.S. EPA and MDEQ that the contamination at the Bofors-Nobel site poses no threat to any water supplies beyond the site boundary as long as adequate capture of contaminated site groundwater continues. In addition, there is no evidence of soil contamination beyond the site boundary. Because of the fact that there has not been any contamination attributable to this site documented past the site boundary, U.S. EPA does not anticipate using Superfund authority in this instance to fund any connection of residences to the Muskegon County water system.

**COMMENT:**

What is the financial assurance mechanism that provides for the funding of this new remedy, since the PRPs are doing the work? Is the total amount of this financial assurance equal to what the government has estimated and what is shown in its public record?

**U.S. EPA'S RESPONSE:**

The U.S. Government has been negotiating a Consent Decree with the PRPs for the site, which is an agreement legally recorded in court. As part of that Consent Decree, there is a provision that the PRPs must provide a financial assurance using one of several possible mechanisms in an adequate amount to cover the estimated costs of the remedy as outlined in this ROD Amendment. For this site, a bankruptcy settlement by the previous site owners / operators was obtained by U.S. EPA and now is held in a dedicated account. This account will also be used to help assure funding for long-term operation and maintenance of the remedy. The settlement will also require the PRPs to provide financial assurance covering all other remedy costs.

**COMMENT:**

During construction of the TIC remedy, will there be any threat of air emissions, especially when installing the trees? If so, how will the community be notified?

**U.S. EPA'S RESPONSE:**

U.S. EPA does not anticipate an excessive amount of dust or other emissions during any portion of TIC remedy construction. Air monitoring will occur during construction activities. If it is discovered that unacceptable levels of dust or other emissions are occurring, the nature, locations, and amount of site activity will be reduced or adjusted accordingly. If discharges continue after such changes are implemented, physical dust control measures such as mist generation or application of foam cover (or other material) will be applied directly at the point of excavation. At the end of each daily construction period, excavation and stockpile areas will be covered appropriately with something such as clean soil, a protective tarpaulin, or foam to prevent releases during off-hours. In the highly unlikely event that any portion of the community might be at risk, local emergency personnel and community members will be notified.

**COMMENT:**

On the property south and west of the site, across Big Black Creek, dumping of debris such as trash, old tires, and old appliances occurs regularly. There is no fencing or other security to prevent this from happening. In addition, improper use of motorcycles and snow mobiles in the area is occurring.

**U.S. EPA'S RESPONSE:**

The Bofors-Nobel southern boundary is Big Black Creek. These unfortunate events are not attributable to this site, nor can they be mitigated by Superfund personnel assigned to this project.

**COMMENT:**

How will contaminated soils in O.U. #2 spaces be "covered" when it is an operating plant and people have to traverse these spaces daily?

**U.S. EPA'S RESPONSE:**

Although all details of the O.U. #2 work are not finalized, the reference to a "protective cover" in this area may refer to installation of a soil, clay, asphalt, or other synthetic cover. This construction would consist of earthwork or "laying down" of asphalt, and can easily occur with appropriate scheduling and temporary isolation. The areas can then be used within a day or two of cover installation.

**COMMENT:**

The rate of the drying up of the Five Lakes area, north and east of the Bofors site is alarming. The groundwater pumping at and near the site is drying up Carr Lake and the other four lakes. Is there any way to divert purified groundwater to re-charge these wetlands?

**U.S. EPA'S RESPONSE:**

Because the Five Lakes area is upstream of the Bofors-Nobel site, it is unlikely that the unfortunate drying of the Five Lakes area is directly attributable to the pumping being performed specifically for the remedy along Big Black Creek. U.S. EPA does not anticipate using Superfund authority in this instance to alleviate this problem. Diversion of treated groundwater to this area would not be cost effective. In addition, because the TIC remedy diverts underground water flow away from Big Black Creek for treatment, this groundwater must be restored to Big Black Creek (after treatment) to insure an appropriate water balance to the Big Black Creek system. With successful implementation of the TIC remedy, groundwater extraction will occur at a lower rate, allowing a greater amount of natural groundwater underneath the site to remain in place.

**COMMENT:**

After the vegetation is installed, allowed to mature, and the TIC remedy has been present for some time, will the vegetation absorb enough contamination where it could be harmful to people, insects, wildlife, or anything else that happens to come in contact with the site?

**U.S. EPA'S RESPONSE:**

Available literature indicates that plant species have the capability to transform organic contaminants to more benign compounds. The literature further documents that plant roots provide a medium under which microorganisms can flourish, and natural destruction of organic contaminants can occur. In addition, the biological fouling of existing extraction wells suggests that there is naturally occurring microbial activity on groundwater contaminants. Based on current research and the characteristics of the vegetative species that have been proposed, U.S. EPA anticipates that if the vegetation in the TIC remedy absorbs enough contamination, it will either be stored However, if TIC remedy vegetation absorbs contamination, it will be stored within the wood deep within the interior of the plant and/or transformed by plant metabolic processes. Contamination should not be present at unacceptable levels at the plant surface (such as tree leaves or bark), constituting an unacceptable risk to insects, birds, or other animals. Site security measures will prevent access to the site, and, as part of the design of the TIC remedy, an assessment of the potential of this kind of threat will be performed. In addition, the site will be monitored for any adverse effects potentially presented by the TIC remedy.

**U.S. ENVIRONMENTAL PROTECTION AGENCY**
**REMEDIAL ACTION**

**ADMINISTRATIVE RECORD**
**FOR**
**BOFORS-NOBEL SUPEFUND SITE**
**OPERABLE UNIT #1**
**MUSKEGON, MICHIGAN**

**UPDATE #6**
**JUNE 11, 1998**

| NO. | DATE | AUTHOR | RECIPIENT | TITLE/DESCRIPTION | PAGES |
|---|---|---|---|---|---|
| 1 | 04/30/96 | Fagiolo, J. & T. Krueger; U.S. EPA | Project File | Memorandum re: *Explanation of Significant Difference for Operable Unit #1 Groundwater Treatment Plant* at the Bofors-Nobel Site | 34 |
| 2 | 05/13/96 | Fagiolo, J. & T. Krueger; *U.S. EPA* | Project File | Memorandum re: *Re-Evaluation of the Selected Remedy for the Soils and Sludges Portion of OU#1* at the Bofors-Nobel Site | 71 |
| 3 | 08/00/96 | U.S. EPA/ OERR | Project File | *Engineering Bulletin: Constructed Wetlands Treatment* (EPA/540/ S-96/501) | 10 |
| 4 | 09/00/96 | U.S. EPA/ OSWER | Project File | Article from *Ground Water Currents: Chlorinated Solvents Biodegradation* (EPA-542-N-96-005) | 4 |
| 5 | 02/24/97 | Hall, B. & K. Wurzel; NewFields, Inc. | Addressees | FAX Transmission re: Minutes of the February 21, 1997 Conference Call Concerning Various Issues for the Bofors-Nobel Site | 2 |
| 6 | 05/16/97 | Bofors-Nobel Site Group | Krueger, T. & J. Fagiolo; U.S. EPA | Letter re: Response to U.S. EPA's April 30, 1997 Letter Concerning the March 30, 1997 *Pre-ROD Workplan for Total In-Situ Containment (TIC) Remedy* for the Bofors-Nobel Site | 57 |

| NO. | DATE | AUTHOR | RECIPIENT | TITLE/DESCRIPTION | PAGES |
|---|---|---|---|---|---|
| 7 | 05/29/97 | Platz, C., U.S. Army Corps of Engineers/ Grand Haven Area Office | Fagiolo, J., U.S. EPA | Letter re: Oversight of PRP Sampling of the Bofors Lagoon Area | 7 |
| 8 | 05/30/97 | Mayka, J., U.S. EPA | Addressees | Special Notice Letter re: the Bofors-Nobel Site w/o Attachments | 9 |
| 9 | 06/00/97 | NewFields, Inc. | U.S. EPA | TriMatrix Lab Reports From Horizon Environmental (Book 1 and 2) | 983 |
| 10 | 06/04/97 | Gilliland, S., DuPont | U.S. EPA | Slides from the May 20, 1997 ARARs Technical Meeting for the Bofors-Nobel Site | 27 |
| 11 | 06/05/97 | Hall. B. & K. Wurzel; NewFields, Inc. | Addressees | FAX Transmission re: Minutes of the June 3, 1997 Agency/Technical Expert Conference Call Concerning the Groundwater Flow Model for the Bofors-Nobel Site | 3 |
| 12 | 06/10/97 | Wurzel, K., NewFields, Inc. | Addressees | FAX Transmission re: Minutes of the June 10, 1997 Conference Call Concerning Sorption Tendencies of Benzidine and DCB | 16 |
| 13 | 06/12/97 | Wurzel, K., NewFields, Inc. | Addressees | FAX Transmission re: Minutes of the June 10, 1997 Agency/Technical Expert Conference Call Concerning Biodegradation/ Attenuation Characteristics of Benzidine and Diochlorobenzidine | 17 |
| 14 | 06/19/97 | Fagiolo, J., U.S. EPA & D. O'Donnell, MDEQ | Bofors-Nobel PRP Group/ Project File | U.S. EPA/MDEQ's Technical Concerns re: the TIC Remedy for the Bofors-Nobel Site | 5 |

| NO. | DATE | AUTHOR | RECIPIENT | TITLE/DESCRIPTION | PAGES |
|---|---|---|---|---|---|
| 15 | 07/11/97 | Wurzel, K., NewFields, Inc. | Fagiolo, J., U.S.EPA & D. Eagle, MDEQ | Memorandum Forwarding Attached Literature re: Information on Phyto-remediation | 321 |
| 16 | 07/18/97 | NewFields, Inc. | U.S. EPA | *Proposed Ecological Remediation Plan* for the Bofors-Nobel Site | 19 |
| 17 | 07/29/97 | Bofors-Nobel Site Group | Krueger, T., U.S. EPA; et al. | Letter re: Settlement of Costs for the Bofors-Nobel Site | 2 |
| 18 | 07/29/97 | Wurzel, K., NewFields, Inc. | Addressees | FAX Transmission re: Minutes of the June 24, 1997 Agency/Technical Committee Conference Call Concerning Agency Concerns with the Proposed TIC Remedy for the Bofors-Nobel Site | 2 |
| 19 | 08/27/97 | Croskey, H., MDEQ | Eagle, D., MDEQ | Memorandum re: MDEQ's Comments on the Bofors Groundwater Flow Model Development and Calibration | 1 |
| 20 | 09/00/97 | U.S. EPA/ OSWER | Project File | Article from *Ground Water Currents: Biodegradation of TCE Through Toluene Injection* (EPA 542-N-97-004) | 4 |
| 21 | 09/09/97 | Newfields, Inc. | U.S. EPA | *Technical Memorandum: Total In-Situ Containment Conceptual Design* for the Bofors-Nobel Site | 866 |
| 22 | 09/10/97 | Graff, C., MDEQ | Eagle, D., MDEQ | Memorandum re: MDEQ's Comments on Three Documents Concerning the Remedial Action at the Bofors-Nobel Site | 4 |
| 23 | 09/17/97 | Roe, C., *Dechert, Price & Rhoads* | Fagiolo, J., et al.; U.S. EPA | Letter re: Correction to Bofors-Nobel Superfund Site PRP Group Technical Memorandum | 2 |

| NO. | DATE | AUTHOR | RECIPIENT | TITLE/DESCRIPTION | PAGES |
|---|---|---|---|---|---|
| 24 | 11/20/97 | Graff, C., MDEQ | Eagle, D., MDEQ | Memorandum re: MDEQ's Comments on the Technical Memorandum Total In Situ Containment Conceptual Design for the Bofors-Nobel Site | 15 |
| 25 | 12/00/97 | *Scientific American* | Project File | Journal Article: *Pollution-Purging Poplars* | 1 |
| 26 | 12/00/97 | U.S. EPA/ OSWER | Project File | Articles from *Ground Water Currents:* (1) *Reactive Barriers for Uranium Removal* and (2) *Enhanced In Situ Anaerobic Bioremediation of Fuel-Contaminated Ground Water* (EPA-542-N-97-006) | 4 |
| 27 | 12/24/97 | Fagiolo, J., U.S. EPA | Hall, B., NewFields; et al. | E-Mail re: U.S. EPA Questions Concerning the Technical Memorandum for the Bofors-Nobel Site | 2 |
| 28 | 01/19/98 | Wurzel, K., NewFields Inc. | Fagiolo, J., U.S. EPA | FAX Transmission re: NewFields/HSI Geotrans' Response to U.S. EPA's December 24, 1997 E-Mail Concerning the Technical Memorandum for the Bofors-Nobel Site | 4 |
| 29 | 01/27/98 | Graff, C., MDEQ | Eagle, D., MDEQ | Memorandum re: MDEQ's Comments on U.S. EPA's Faxed Letter Concerning Responses to the December 24, 1997 E-Mail to NewFields/HSI Geotrans on the Technical Memorandum for the Bofors-Nobel Site | 1 |
| 30 | 04/17/98 | Fongers, D., MDEQ | Eagle, D., MDEQ | Memorandum re: MDEQ's Comments on the Bofors Particle Tracking Analysis of Advective Transport | 3 |

| NO. | DATE | AUTHOR | RECIPIENT | TITLE/DESCRIPTION | PAGES |
|---|---|---|---|---|---|
| 31 | 05/00/98 | U.S. EPA/ OSWER | Project File | Articles from the May 1998 Issue of *Tech Trends:* (1) *Long Term Phyto-remediation of Organic Soil Pollutants* and (2) *Phytoremediation of Selenium Laded Soils* (EPA 542-N-98-005) | 4 |
| 32 | 06/15/98 | U.S. EPA | Project File | *Proposed Plan* for the Second Amendment to the Record of Decision for the Soils and Sludge Portion of Operable Unit #1 at the Bofors-Nobel Site | 11 |